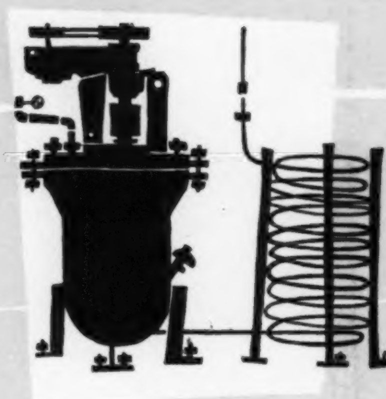
MINING ENGINEERING

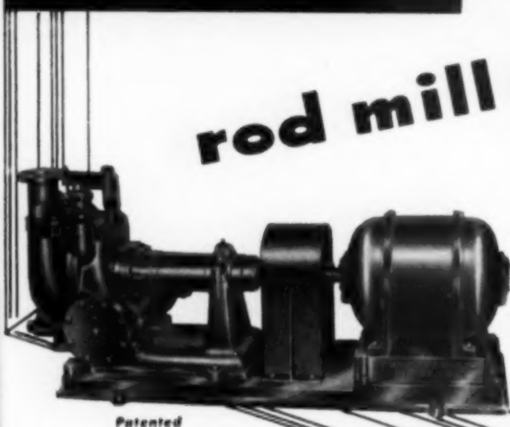
JUNE 1952
IN TWO SECTIONS—SECTION 1



CHEMICAL PROCESS RECOVERS PURE METAL

WILFLEY
centrifugal PUMPS

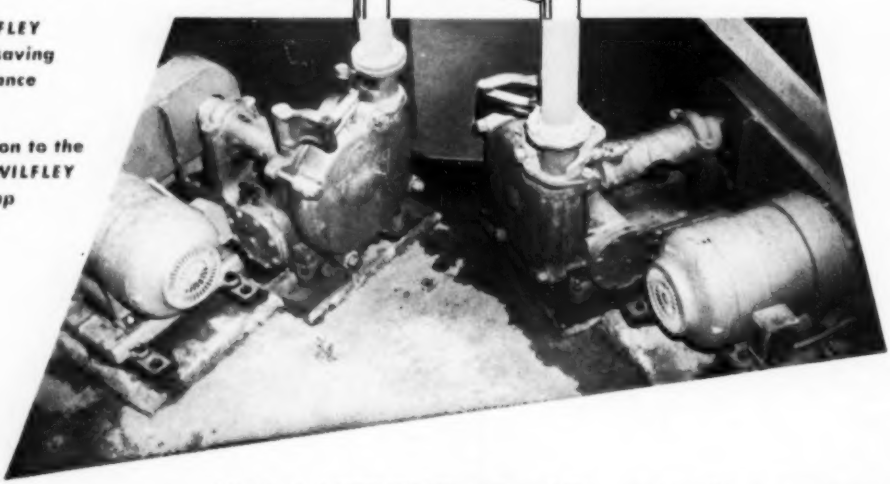
Handling
rod mill discharge



The Model "K" WILFLEY is THE pump to buy when the job calls for a rugged, heavy-duty pump that delivers higher efficiencies, stepped-up production, worthwhile power savings and lower operating costs. Continuous, 24-hour-a-day performance. Easy interchangeability of wear parts. Low maintenance costs. Every application individually engineered. Write or wire for details

Buy WILFLEY for cost saving performance

Companion to the famous WILFLEY Acid Pump



5" Model "K" Wilfley Sand Pumps in a large western sand and gravel plant handling 30% solid discharge containing highly abrasive 3/16" silica from rod mill.

A. R. WILFLEY & SONS INC., DENVER, COLORADO, U.S.A.
NEW YORK OFFICE: 1775 BROADWAY, NEW YORK CITY

MINING ENGINEERING

Incorporating Mining and Metallurgy, Mining Technology and Coal Technology

VOL. 4 NO. 6 JUNE, 1952

In Two Sections — Section 1

JOHN V. BEALL
Manager of Publications
Editor, Mining Engineering

• • •

CHARLES M. COOLEY
Associate Editor

• • •

G. M. ZILL M. A. MATZKIN
N. M. VITULLO M. E. SHERMAN
Assistant Editors
GRACE PUGSLEY, Production Manager;
W. J. SEWING, Asst. Prod. Mgr.

• • •

TECHNICAL PUBLICATIONS COMMITTEE
J. I. LAUDERMILK........Chairman
E. J. KENNEDY, JR........Secretary
AUXILIARY PUBLICATIONS COMMITTEE CHAIRMEN
R. D. LEISK........Mining
EDWARD WISSER........Geology
FLORENCE ROBERTSON........Geophysics
M. D. HASSIALIS........Beneficiation
H. P. GREENWALD........Coal
BRUCE C. NETSCHERT....Indus. Minerals
J. P. NIELSEN........Education
H. A. FRANKE........Mineral Economics

• • •

J. A. STANGARONE
Advertising Manager
B. C. SNELL
Regional Manager
1110 McDonald Place
Sewickley, Pa.
Western Representatives:
McDONALD-THOMPSON
625 Market St.
San Francisco 4, Calif.

• • •

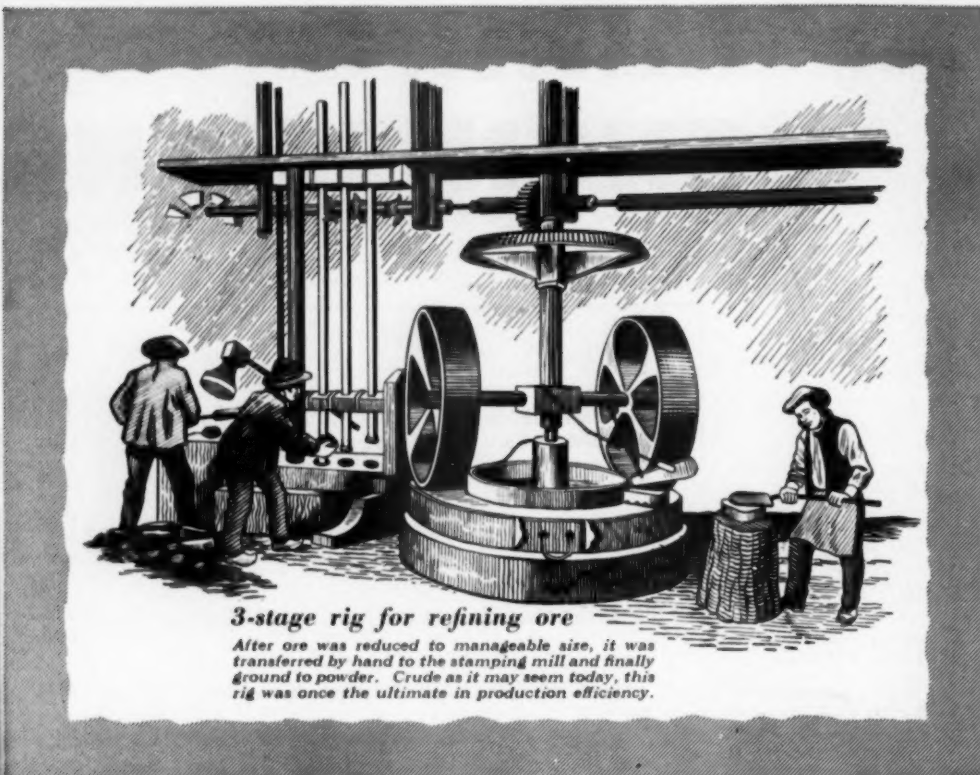
The AIME publishes {Mining Engineering / Journal of Metals / Journal of Petroleum Technology}

Published monthly by the American Institute of Mining and Metallurgical Engineers, Inc., 29 West 39th St., New York 18, N. Y. Telephone: PEnnsylvania 6-9220. Subscription $8 per year for non-AIME members in the U. S., & North, South & Central America; $9 foreign; $6 for AIME members, or $4 additional in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies $.75; special issues $1.50. The AIME is not responsible for any statement made or opinion expressed in its publication. Copyright 1952 by the American Institute of Mining and Metallurgical Engineers, Inc. Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by The National Research Bureau. Entered as second-class matter Jan. 18, 1949, at the post office at N. Y., N. Y., under the act of March 3, 1879. Additional entry established in Manchester, N. H. Member, ABC

FEATURES

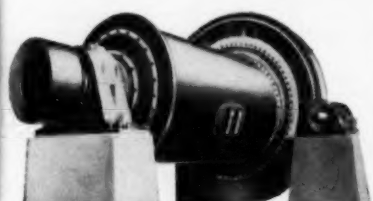
ARTICLES

TRANSACTIONS



3-stage rig for refining ore

After ore was reduced to manageable size, it was transferred by hand to the stamping mill and finally ground to powder. Crude as it may seem today, this rig was once the ultimate in production efficiency.



Traylor builds four types of grinding mills in a wide choice of sizes to meet your exact needs.

History excitingly illustrates the speed with which our machine age advances. And Traylor is proud of the part it plays in this movement. For 50 years, Traylor has led in developing new designs and producing better machinery for the mining industry. In that time, Traylor equipment has gone all over the world, building a name famous for efficient operation. It takes experience to come up with the right answers consistently. Traylor has experience . . . half a century of it. Use it to your advantage.

OUR GOLDEN ANNIVERSARY YEAR
1902 1952

TRAYLOR ENGINEERING & MANUFACTURING COMPANY
474 MILL ST., ALLENTOWN, PA.
SALES OFFICES: New York • Chicago • Los Angeles
Canadian Mfrs: Canadian Vickers, Ltd., Montreal, P. Q.

a **Traylor** *leads to greater profits*

... Beat ... Eimco

The tougher the job the more essential it is that you load with an EIMCO. Leading underground needs the dependability of

equipment that can stand up to the unexpected and keep right on working. On contract jobs you need the speed that EIMCO equipment provides even on "under par" air pressures. On

long high-speed tunnels you need the flexibility of EIMCO equipment to load big cars to capacity. Safe, low-cost loading is yours with EIMCO loaders.

There is an EIMCO for every loading job.

EIMCO

THE EIMCO CORPORATION

The Leader in the Manufacture of [illegible] Equipment

EXECUTIVE OFFICES AND FACTORIES SALT LAKE CITY 10, UTAH, U. S. A.

BRANCH SALES AND SERVICE OFFICES

NEW YORK 51-52 SOUTH STREET • CHICAGO 3319 SOUTH WALLACE STREET

BIRMINGHAM, ALA. 3140 FAYETTE AVE. • DULUTH, MINN. 216 E. SUPERIOR ST.

EL PASO, TEXAS MILLS BUILDING • BERKELEY, CALIF. 637 CEDAR STREET

KELLOGG, IDAHO 307 DIVISION ST. • LONDON W. 1, ENGLAND 190 PICCADILLY

IN FRANCE: SOCIETE EIMCO, PARIS, FRANCE

IN ENGLAND: EIMCO GREAT BRITAIN, LTD., LEEDS 12, ENGLAND

AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD

"Carlon won't Corrode!"

"Amazing pipe, that CARLON! We've used it to handle wastes so corrosive they quickly eat through metallic pipe—but even after years of service, CARLON's as good as new. It just won't corrode!"

CARLON is the only pipe that is guaranteed against rot, rust and electrolytic corrosion. It features absolute resistance to the chemical attack of sulphurous waters, alkalies, and metallic salts. Permanent free-flow is assured by the smooth internal surface which will not accumulate scale or sediment.

CARLON plastic pipe is lightweight . . . flexible . . . can be installed quickly without special tools or rigging equipment. Furnished in long lengths which conform to irregular surface contours, it requires fewer fittings.

Recommended applications include drinking water and drainage systems, ventilating lines, hydraulic sluicing, intake and exhaust piping, dredge discharge lines, low-pressure air lines, etc.

NOM. SIZE	O.D.	I.D.	EST. BURST P.S.I.	WT. LBS. PER FT.	SHPG. LENGTHS
½"	0.840	0.622	540	0.103	400 ft. coils
¾"	1.050	0.824	350	0.140	400 ft. coils
1"	1.310	1.070	200	0.181	300 ft. coils
1¼"	1.660	1.380	200	0.267	300 ft. coils
1½"	1.900	1.610	200	0.320	250 ft. coils
2"	2.378	2.070	170	0.445	200 ft. coils
2½"	2.875	2.469	170	0.680	200 ft. coils
3"	3.504	3.070	165	0.910	100 ft. coils
4"	4.504	4.030	150	1.250	25 ft. str.
6"	6.630	6.070	115	2.230	25 ft. str.

Identification Stripe: WHITE—Standard Pipe
RED—Heavy-duty Pipe

CARLON CP

Specify the Pipe with the Stripe!

582-CP

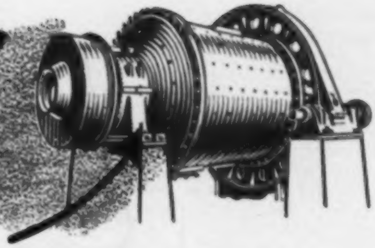
Write for Catalogs

CARLON PRODUCTS CORPORATION

In Canada: Micro Plastics, Ltd., Acton, Ontario

10300 MEECH AVENUE • CLEVELAND 5, OHIO

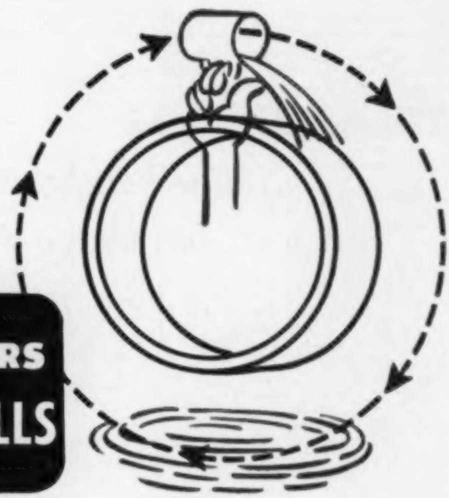
"Inside Story"



# of Allis-Chalmers Oil Lubricated Trunnion Bearing...

An oiling bucket inside this Allis-Chalmers trunnion bearing revolves with the trunnion . . . lifts oil from the reservoir in the bottom of the bearing housing to an oil distributing pan above the bearing. From here it floods down onto the bearing, lubricating the full face of the bearing uniformly and continuously.

You'll always have the comforting assurance that the all-important trunnion bearing on your mill is being dependably lubricated. This assured protection of internal lubrication is standard on all Allis-Chalmers oil lubricated bearings — even on installations where a separate external oiling system is used. A-3722



ALLIS-CHALMERS GRINDING MILLS

These protective features of A-C trunnion bearings also give you savings in power and maintenance —

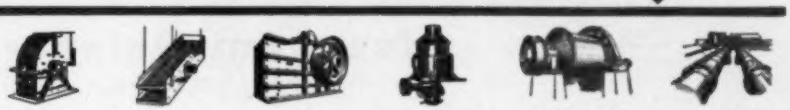
- ★ **An improved seal keeps dirt out of oil and has been designed to provide for mill expansion.**
- ★ **A hand operated, high pressure lubricant pump "floats" the mill after shut-down . . . eliminates dry starting.**
- ★ **If desired, an external system for filtering and cooling can be added to the internal oiling system.**

Get more facts from the Allis-Chalmers representative in your area, or write for Bulletin 07B6718A. Allis-Chalmers, Milwaukee 1, Wis.

ALLIS-CHALMERS

A-C

Sales Offices in Principal Cities in the U. S. A. Distributors Throughout the World.



Hammermills · Vibrating Screens · Jaw Crushers · Gyratory Crushers · Grinding Mills · Kilns, Coolers, Dryers

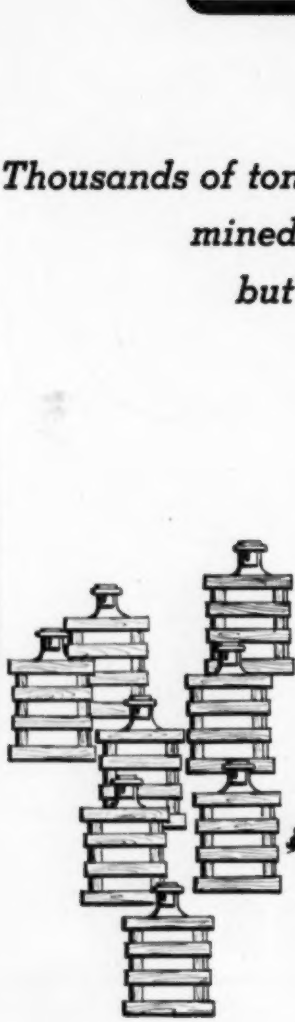
Sulphur

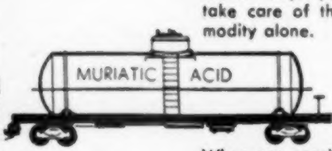
Loading a ship with Sulphur at Galveston

Thousands of tons mined daily, but where does it all go?

PARAPHRASING an old saying: 'It takes a chemical to make a chemical,' certainly applies to hydrochloric acid.

No chemical engineer has to be told how hydrochloric acid is made but sometimes with the mind focussed on the word "hydrochloric" little thought is given to another word "sulphuric." It is this word that calls attention to the fact that to make one net ton of 20° Bé hydrochloric acid by the H_2SO_4 process requires about 950 pounds of this acid, basis 100%, which is equivalent to 320 pounds of Sulphur. About one third of the annual hydrochloric acid production is made by the use of sulphuric. The sulphur is not lost because salt cake, a by-product, also has commercial value. But any way you figure it, the hydrochloric acid industry is an important consumer of Sulphur in the form of sulphuric acid. In fact, it takes several days' production from all the Sulphur mines to take care of the annual production of this one commodity alone.





When one considers all the other chemicals that require sulphuric acid or other Sulphur compounds for their manufacture, it is not difficult to appreciate how faithfully the Sulphur Industry is serving industry today in spite of the great demands made upon it.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

Personnel Service

THE following employment items are made available to AIME members on a non-profit basis by the Engineering Societies Personnel Service, Inc., operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

MEN AVAILABLE

Geologist-Petrographer. Experienced subsurface geology and petrographic rock and mineral identification. Desires position as either geologist or petrographer. M-682.

Geologist, 36, married, employed. Nine years' experience geology connected with engineering, includes planning and supervising core drilling programs, study of stratigraphy and structure, special problems, report writing. Three years' teaching experience. Desires responsible position offering opportunity for advancement with progressive concern. Will travel part time. Available reasonable notice. M-683.

Mining Executive with record of accomplishment organizing and directing efficient low cost mining and ore dressing operations available for position in the United States. Broad experience engineering, mechanized mining, flotation, safety, union labor relations and preparation of reports. Married. Employed; available upon reasonable notice. M-684.

ECONOMIC GEOLOGIST of metallic ore deposits. Teach ore deposits, polished surfaces, and mineralogy. Knowledge and experience in metal mining desirable. Location: well-known, Western school of mines, on a university campus. Salary and rank open, depending upon training and experience.

Box D-8 MINING ENGINEERING

EXTRACTIVE METALLURGIST. Half-time teaching, half-time research. Research in ore preparation and concentration; including flotation. Should be able to teach these subjects and perhaps a course in process or production metallurgy. Location: well-known, Western school of mines, on a university campus. Salary and rank open; depending upon training and experience.

Box D-9 MINING ENGINEERING

EXTRACTIVE METALLURGIST. Direct research project dealing with ore preparation and concentration; including flotation. Should be well-trained and experienced in ore dressing and competent to direct men. Project will contain six to nine men. Expected to take charge of project and obtain personnel. Location: well-known, Western school of mines, on a university campus. Salary and rank open; depending upon training and experience.

Box D-10 MINING ENGINEERING

POSITIONS OPEN

Flotation Metallurgist, technical graduate, preferably over 30, with knowledge of Spanish, to run 50-ton/day flotation pilot plant on copper porphyry ore. Three year contract. Single or single status. Elevation 10,500 ft. Salary, $5400 to $7200 depending on applicant. Location, South Peru. S-226.

Recent Graduate in ore mining, to handle surveying, mapping, geology and the laboratory for new manganese mine and mill in Virginia. Y6985.

Mining Engineers experienced in design, layout and cost estimating for new mines and production plants. Should be capable of supervising construction on all such projects. Must have rather broad practical and technical knowledge of mining and milling operations. Salary, $6000 to $6600 a year. Occasional travel. Location, Texas. Y6976.

Engineers. (a) Assistant Mine Engineer for underground surveying, miscellaneous underground engineering problems. Engineering degree desirable, mine experience desirable. Salary, $3900 a year. (b) Mining Methods Study Engineer, for methods and time studies or ore handling, drilling, blasting, and some mine planning. Mining degree essential, mine experience essential. Salary, $4200 to $4800 a year. (c) Technical Assistant to Mill Superintendent for metallurgical testing, metallurgical calculations and design of minor alterations to mill. Position may lead to supervisory assistant to mill superintendent. Salary open. (d) Junior Electrical and Mechanical Engineer, to inspect underground mining equipment and supervise electricians and mechanics in maintenance of electrical and mechanical equipment. Will act as assistant to maintenance superintendent. Technical training and some practical experience necessary. Interest in mining essential. Salary open. Location, New Jersey. Y6958.

Teaching Personnel. (a) Assistant Professor in mining engineering, 25 to 35, with some practical and/or teaching experience, to teach mining engineering. Salary about $4000 for nine months depending on training and experience. (b) Instructor with some practical experience, to teach mining engineering. Opportunity for graduate work. Salary about $3500 for nine months depending on experience. Location, West. Y6952S.

Mining Engineer who has had considerable construction experience, preferably underground hematite iron ore mining experience. Location, Greece. Y6937.

Engineers. (a) Superintendent of mines, mining graduate, with considerable experience in dirt moving, drainage, etc., as well as a thorough knowledge of the equipment handled, such as draglines, shovels, trucks, drills, etc. (b) Superintendent of Washing and Beneficiating Plant, experienced in washing a very sticky clay, and experienced with heavy media and Dutch cyclone operation as well as some knowledge of modulizing, briquetting or sintering. Salary open. Location, Arkansas. Y6928.

SCRUBBER UNIT TANKS, BEARINGS AND DRIVES

Subject to prior sale.
FOB Jacksonville, Fla.

19 Steel Tanks 4.0½ x 4.0⅜ x ¼"
1 High Cone, Bottom of Tank 20" dia.
25 4' x 4' heavy duty agitator mechanisms
8' x 8' superstructures
18" OD x 16" high standpipe
1150 RPM unit speed. 180 RPM shaft speed. Shaft dia. 3 7/16"
8 10/b/58 PD Sheaves
2⅛" bore ½x½x⅛" keyway
25 10/b/38 PD Sheaves
2 15/16" bore
¾x⅜x3/16" keyway
18 Belt Guards
80 B 158s Gates Super Vulco Ropes

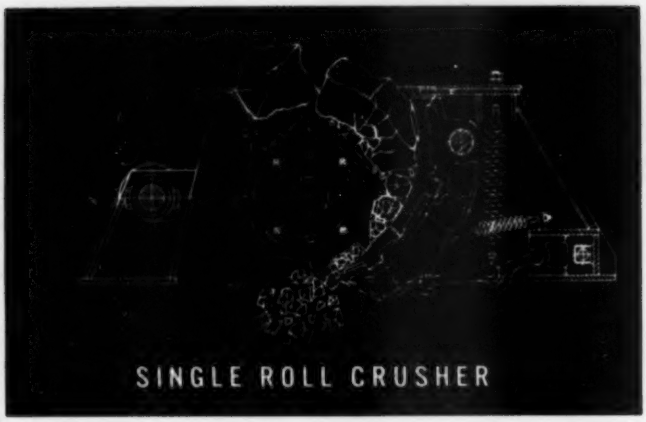
ALBRIGHT & COMPANY
18th and Evergreen Ave.
Jacksonville 6, Fla.

FOR SALE: Diamond Core Drill Rig. Sullivan wheel mounted complete rig—$2,500. A bargain.

Independent Stave Co.
P.O. Box 104 Lebanon, Mo.

NEW ORES DISCOVERED. WYOMING. One telluride vein 7 ft. wide, assaying $37.10 in gold to $49.70 in silver. Two hornsilver veins, one 4 ft. 9 in., one 8 ft. Three galena veins, one 2 ft. wide; one 4-in., and one 8-in. vein. All widths given from outcrop on surface, assaying $200 up to $300; 22 to 120 oz. of silver, lead 80 to 86%. Require $150,000 for equipment and payroll. Only two weeks' work necessary to get ore in tunnels. Sixty miles to railroad.

H. S. HARDEE
446 S. Linden Ave.
Sheridan, Wyoming



CRUSHES BY IMPACT, SHEAR AND COMPRESSION

As the feed moves into the crushing zone of a Pennsylvania Single Roll, it is struck by the roll teeth (impact), followed by a shearing action as the teeth move downward; the smaller pieces are then swept into the final point of narrow clearance between the teeth and the breaker plate, and are subjected to a powerful compression that shatters to a size that permits passage from the crushing zone. In this machine, reduction ratios are high but power demand is low.

We've a lot of data and experience that can't help but be valuable to anyone who wants to crush anything—chemical solids and metallurgical products particularly. Our job analysis service costs you nothing and may save a lot. Write us.

PENNSYLVANIA CRUSHER COMPANY

1728 Liberty Trust Building, Philadelphia 7, Pa.

Division of Bath Iron Works Corporation

New York • Boston • Pittsburgh • Birmingham • Tampa • Detroit • Chicago
St. Louis • Crosby, Minn. • Los Angeles • London, England

send for bulletins

Lead Man experienced in flotation and gravity concentration for a copper-gold ore mill. Knowledge of flotation and gravity concentration, plus the ability to make ordinary mill repairs. Will supervise all mill men on shift work. Salary, $4500 a year with room and board for single man at $2.90 a day. Housing facilities available. Day shift only, except in emergencies. Location, Montana. Y6926.

Assistant Professor, young, with at least an M.S. degree in mining engineering or equivalent, to assist in teaching mining courses. Will attend to the preparation of course outlines, some correspondence, and final examinations for the mining extension courses given in the field by qualified mining engineers. Position starts July 1, or September 1, 1952. Salary dependent on experience. Location, South. Y6739.

Assistant Concentrator Superintendent for large mining company. Must have had considerable experience with lead, zinc and copper concentrators. Spanish helpful. Three-year contract, transportation, living quarters. Location, South America. Y6684.

Engineers. (a) Mine Foreman with at least three years' underground experience for lead-zinc operation. Salary, $4800 a year plus housing and family accommodations. Must speak Spanish. Location, Peru. Y6679.

Engineers. (a) Mining Engineer with open-pit and underground experience, to plan production layout and improvements on copper project. Salary, $5200 to $6500 a year. (b) Engineering Draftsman to do mapping, cross-sections, etc., covering mining work. Salary, $3900 to $4420 a year. Location, South America. Y6530.

Mining Engineer with experience on small open-pit foreign manganese projects, to take charge of operations at West Africa Gold Coast property. Salary open. Y6527.

Mining Engineer, 35 to 45, with experience on alluvial deposits and underground mining, to supervise operation of diesel shovels, draglines, International tractors, belt conveyors, stripping and transporting alluvial gravel to mill. Must be able to handle native labor. Knowledge of French essential. Salary, $10,000 a year plus room and board. Location, French Equatorial Africa. Y6320.

The position of Senior Lecturer in Ore Dressing is open at the University of Melbourne. For further information, contact

J. S. ROGERS
University of Melbourne
Melbourne, Australia

It's New!
Le Roi-CLEVELAND
S11ST Offset Telescopic Leg Stoper
It's Fast!
...and sized right
3 Sizes — 28" - 40" - 52" Feeds
It's Tough!
Built right by the leading manufacturer of offset and roof-bolting stopers!
Only Le Roi-CLEVELAND S11ST gives you all these features for dependable, low-cost drilling
★ Convenient right-hand feed control provides the right feeding pressure for fast drilling in any rock.
★ Trip rotation release allows piston to strike straight, hammer-like blows.
★ Feed leg supported at backhead and chuck housing for extra strength.
★ Fewer packings to replace in air-feed leg means less trouble, easiest servicing.
★ Button in handle provides fast, positive feed release, for quicker, easier steel changing.
★ Constant blowing around front end prevents slush and cuttings from entering drill at front end and greatly reduces wear.
★ Water tube can be removed quickly —you don't have to dismantle the machine, just take off the backhead plug.
★ Shielded safety handle protects operator's hands.
★ Air consumption is low.
Standard Le Roi-CLEVELAND S11 Offset Stopers can be converted to this new telescopic type.
So get set for faster drilling and lower costs — standardize on these new stopers. Write for complete details.
LE ROI
LE ROI COMPANY

Meet The Authors

W. N. Triplett *(Geology of the Silver-Lead-Zinc Deposits of the Avalos-Providencia District of Mexico, P. 583)* was born in Tecumseh, Mich., and attended the University of Michigan and Massachusetts Institute of Technology. From 1912 to 1917 he worked for Moctezuma Copper Co., a Phelps Dodge subsidiary at Nacozari, Sonora, Mex. He served in Army as Second Lieutenant Field Artillery from 1917 to 1918 and from 1919 to 1922 returned to Moctezuma Copper Co. From 1922 to 1952 he has been with Compania Minera de Penoles, S. A., a subsidiary of American Metal Co., Monterrey, N. L., Mexico in Unit Dept. as chief geologist and at present is consulting geologist. Mining geology and operation is of particular interest to Mr. Triplett. He presented a previous paper before with M. W. Hayward entitled, "Occurrence of Lead-Zinc Ores in Dolomitic Limestones in Northern Mexico." Besides being an AIME member, he holds membership in Society of Economic Geologists. Fishing, hunting and photography are his favorite hobbies.

P. J. SHENON

P. J. Shenon *(Geological Engineering—A Curricular Outcast?, P. 568)* was born in Salmon, Idaho. He received a B.S. in mining, M.S. in metallurgy and Ph.D. in geology. Mr. Shenon has worked for International Nickel Co. as exploration geologist, for USGS as regional geologist and at present is head of department of mining at University of Utah. An AIME member, Mr. Shenon prepared an annual review article for *Mining & Metallurgy* in February 1948 on mining geology and had an article on Review of Structural Geology of Canadian Ore Deposits in MINING ENGINEERING in April 1940. Travelling, fishing, and hunting are his favorite pastimes.

J. C. Detweiler *(Jacksonville Plant Produces Titanium from Beach Deposits, P. 560)* was born in Los Angeles, Calif., and attended University of Denver. He worked as chief chemist for Charles O. Parker & Co., from 1940 to 1942. Mr. Detweiler was test engineer with Denver Equipment Co. from 1942 to 1945 and was a chemist and metallurgist with Humphreys Gold Corp. at Jacksonville, Fla., from 1945 to 1950. At present he is technical superintendent at Humphrey's Gold Corp. Trail Ridge Plant. An AIME member, he resides in Keystone Heights, Fla. Reading and photography are his favorite pastimes.

F. C. Pearson *(Power Facilities at a Modern Anthracite Open-Pit Mine, P. 578)* was born in Mahanoy City, Penna. and attended Chicago Engineering Works. He started as a breaker boy in 1916. Mr. Pearson studied electricity and worked in and about the mines as electrician until 1946 when he was appointed electrical superintendent for the Shen Penn Production Co., a subsidiary of the Philadelphia & Reading Coal & Iron Co. For 20 years he was supervisor of fire alarms for Mahanoy City Boro. An AIME member, strip mining is of special interest to him. Hunting is his favorite pastime.

F. E. TURTON

F. E. Turton *(Mining Operations at the Teniente Mine of the Braden Copper Company, Rancagua, Chile, P. 573)* was born in Oakland, Calif. and attended University of California. He received a M.A. degree in 1915. He has worked for Braden Copper Co., in Chile, South America from 1915 to present—as assistant general manager from 1930 to 1944; from 1944 to 1951 he was general manager and at present he is vice president. Industrial relations are of special interest to him. Besides holding membership in AIME, he is a member of Club de la Union, Santiago, Chile, S. A. Hunting, fishing, golf and photography are his favorite hobbies.

C. L. Thornburg *(The Surface Expression of Veins in the Pachuca Silver District of Mexico, P. 594)* was born in Salt Lake City, Utah and attended West Side high school and University of Utah. He received a B.S. in geological engineering in 1923. After graduation he worked at Utah Copper (Kennecott) as surveyor and assistant geologist until leaving for Mexico in 1925 to take charge of the engineering department for El Potosi Mining Co., subsidiary of Howe Sound Co., in Chihuahua. In 1927 he went into operation and worked as a foreman until placed in charge of the mine geological department in 1928. In the course of extensive examination work he eventually became chief geologist for the Howe Sound Co. operations in Mexico. In 1936 he left the former connection to be chief geologist for Cia. de Real del Monte y Pachuca at Pachuca, Hgo., Mexico, a former subsidiary of the U. S. Smelting, Refining & Mining Co. He held this position until 1947 when he returned to the United States to work in the parent company's exploration department. In recent years he was engaged in exploration work in western states. He is now mines geologist for U. S. Smelting, Refining & Mining Co. Besides being an AIME member, he holds membership in Society of Economic Geologists.

E. R. Ermert *(Power Facilities at a Modern Anthracite Open-Pit Mine, co-authored by Frederick C. Pearson and Albert Brown (deceased))* was born in Ashland, Pa., and attended Ashland high school. He has been with Philadelphia & Reading Coal & Iron Co. in various engineering capacities, five years as chief engineer. An AIME member, he now resides in Ashland, Penna.

Tell Ertl *(Prospecting the Piceance Creek Basin for Oil Shale, P. 601)* was born in Seattle, Wash. and attended University of Washington and Columbia University. He received a B.S., M.S. and Ph.D. Mr. Ertl was a contract miner, Belmont Mine, Butte, Mont. from June 1940 to August 1940. From 1940 to 1941 he was an assistant in mining engineering at Columbia University. He was a consulting engineer with the International Mining Co. in La Paz, Bolivia from June 1941 to September 1941. He was assistant professor, school of mining engineering, University of Kansas from 1942 to 1944. From 1943 to 1944 he was assistant dean, school of engineering and architecture, University of Kansas. The Bureau of Mines employed Mr. Ertl as engineer in charge, oil shale mining section, Dept. of Interior from 1944 to 1948. Mr. Ertl was a mining engineer with Union Oil Co. of California from 1948 to 1950. At present he is professor and chairman of mining and petroleum engineering dept., Ohio State University. An AIME member, he was chairman of San Juan Subsection and director of Colorado section. Mine visiting is his favorite hobby. Mining costs and oil shaling are of particular interest to him.

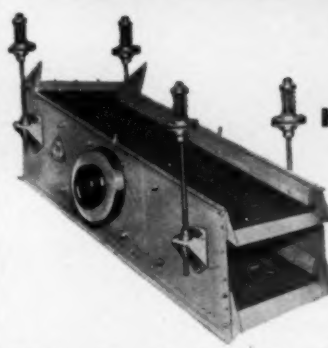
Denver "Sub-A" Flotation

Denver Cross-Flow Classifiers

Denver Hydroclassifiers

Denver Super-Agitator and Conditioners

DENVER-DILLON Vibrating Screens



SAVE UP TO 50% HORSEPOWER

Denver Reagent Feeders

Denver Pulp Distributor

Denver Thickeners

Denver Jaw Crushers

Notice, on Denver-Dillon Vibrating Screens, that bearings are not anchored to heavy channel iron or other supports. Weight of screen and load is suspended. Bearings support only weight of flywheels and shaft. Screen is free of restrictions to impart maximum vibration to entire screen body.

You save on initial cost, too, for this patented action eliminates unnecessary weight and fabricating costs.

Please write to us about your requirements. Quantity production of standard equipment means lower cost and good deliveries • Complete mill equipment from testing to feeder to dryer.

Denver "Sub-A"— for 25 years the greatest name in **Flotation Engineering.**

Many of our machines are in stock.

FLOTATION ENGINEERS

"The firm that makes its friends happier, healthier, and wealthier"

DENVER EQUIPMENT COMPANY

P.O. BOX 5268 • DENVER 17, COLORADO

DENVER • NEW YORK CITY • CHICAGO • EL PASO • TORONTO • VANCOUVER • MEXICO D.F. • LONDON • JOHANNESBURG

ECONOMICAL TRANSPORTATION

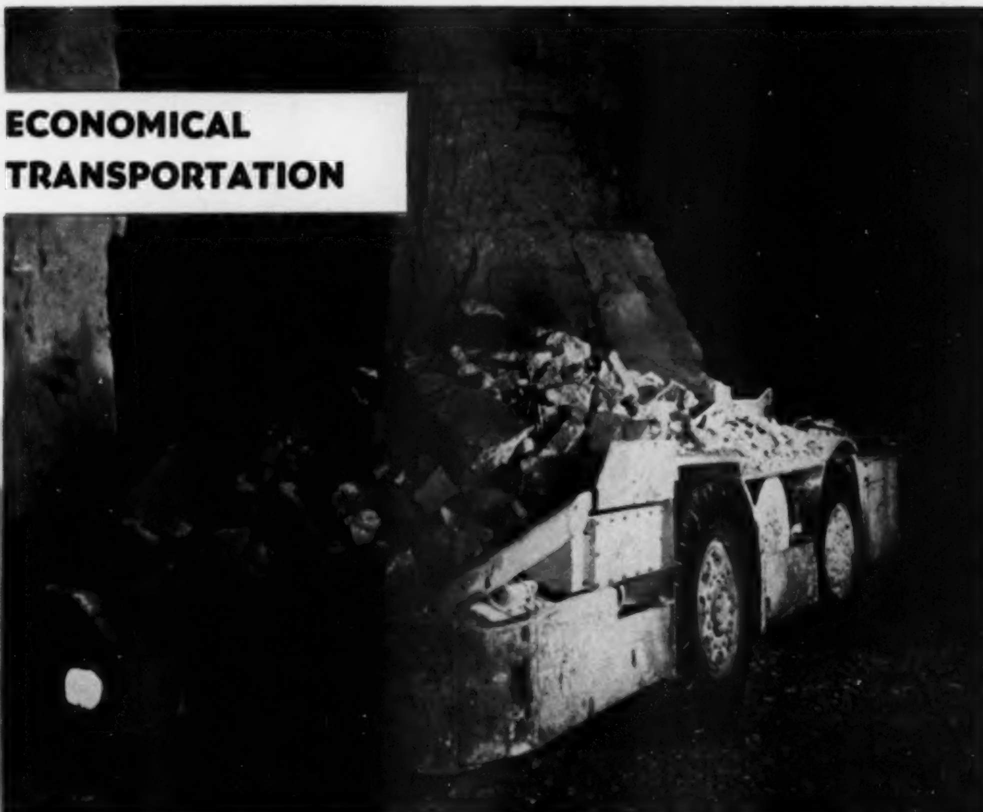


Photo above shows a Jeffrey Shuttle Car in a large lead mine. Note carrying capacity.

FOR THE METAL MINE

Consider the Jeffrey Shuttle Car for high production and low cost per ton in transporting material when and where you want it most. These improved cars have many features: rigid design; airplane disc-type, 4-wheel hydraulic brakes; hydraulically-driven variable speed Conveyor; hydraulic booster steering; etc. We'll be glad to go into more detail.

Products:

Locomotives
Drills
Trammers
Feeders
Magnetic Separators
Chains
Crushers
Bucket Elevators
Fans and Blowers
Conveyors
Grizzlies
Screens
Car Pullers
Pulverizers

THE JEFFREY

ESTABLISHED 1877

Complete Line of Material Handling, Processing and Mining Equipment

GARDNER-DENVER

automatic feed drifters

—Low vibration simplifies set-up.
—Self-adjusting feed maintains high drilling speed.
—Powerful rotation handles tight steel, saves lost holes.
—Convenient controls boost drill runner's efficiency.
—Long feed guide shells for fewer steel changes.

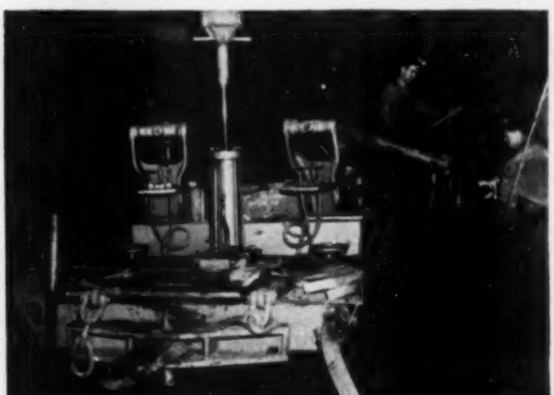
DRIVE HEADINGS FASTER with this DOUBLE PUNCH!

GARDNER-DENVER

hydraulic drill jumbos

—Faster set-up—move in and start drilling.
—Long feeds—up to 10 feet—give more actual drilling time per shift.
—"Creep-free" booms — maintain steel alignment.
—Offset booms spot lifters easily.
—Faster tearing down — release hydraulic pressure and back away.

Write today for full details.



SINCE 1859

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

Resistant Tape

A new oil-resistant tape for rapid insulation build-up on splices in large power cables has been announced by *Minnesota Mining & Mfg. Co.* Designated Scotch brand electrical tape No. 25 is made of synthetic rubber providing greater dielectric strength and resistance to high temperatures. The chemical-resistant qualities of the tape make it suitable for use in oil drilling, mining and underground

cable operations, while the 40-mil thickness and extreme stretch (1500 pct breaking point) make possible smooth insulation wraps on irregular surfaces. Dielectric strength is 15,000 v and 10,000 v at 500 pct elongation. It has an electrolytic corrosion factor of 1.0 and an insulation resistance of 100,000 megohms. **Circle No. 1**

Hydra-Lift

The Pitman Mfg. Co. announces that is now has in production a new model of the Pitman hydra-lift, recently-developed crane with hydraulically-powered boom that can be mounted on the frame of any truck, 1½ tons or larger. According to the manufacturer, the new model hydra-lift model B features a variety of improvements over the original production model, introduced late in 1950. Changes incorporated in the new model, according to officials, not only have resulted in improved crane, but also have given the unit a new profile which distinguishes it sharply from the original model. The two chief improvements in the new model are: a big increase in the unit's safety margin and the fact that it is now shipped almost completely preassembled, cutting the time and cost of installation. Rated capacities of the hydra-lift are based on the tipping factor of a 1½ ton truck, with outriggers down, and thus have not been increased. **Circle No. 2**

Belt Testing Machine

A laboratory conveyor belt testing machine designed by *Raybestos-Manhattan's* company engineers is now in operation at their Passaic, N. J., laboratory. This machine puts any 30 in. wide 80 ft length of conveyor belt through its paces up to 200,000 lb total tension. Being the first machine of its kind, there was much original research and engineering involved. It will benefit industries that move bulk material in large quantities, particularly coal and ore mining, quarries, large plants and coal-fueled utilities. Factual recorded observations on this machine show the effect of pulley size, actual strength and factors of safety of a conveyor belt running over pulleys with any predetermined amount of tension load and overload. The relation between troughability, load sag between idlers, thickness of belt and tension, is shown. **Circle No. 3**

Conveyor Systems

The successful application of overhead monorail cable conveyor systems to heavy duty, as well as lightweight materials handling purposes, was recently reported by Detroit manufacturers. The use of 9/16 steel core cable in joining trolley brackets was accomplished with satisfaction, according to the firm's engineers. In the D-G system, the cable passes through the sleeves of the split bracket. The sleeves have internal serrations. Externally, they are tapered in shape and threaded. When the cable is enveloped by the bracket sleeves, the halves of the split nut are then brought together on the sleeve and turned on the expanding threads of the taper. In this way the nut exerts a 360° compression on the sleeve causing it to establish a bitt hold on the cable with its internal serrations. *Daigle-Gaboury, Inc.* **Circle No. 4**

Skid Shovels

The Drott Mfg. Corp. is now in full production on the new line of skid-shovels, built exclusively for International tractors in these models and capacities: TD-9—1¼ yd, TD-14A—2 yd, and TD-18A—3 yd. The new Drott skid-shovel has a clean design. There are no hoses or pipes cluttered around the operator. All hydraulics are fully enclosed and protected. The rear end is free for mounting auxiliary equipment. Low overall clearance permits work in confined areas. A patented Drott featured called break-out action gives the bucket a crowding action at every bite, assuring a heaped load from any cut. The bucket is rolled back as much as 28 in. before the load is lifted, and that extra yardage does not slip off the heap. Loads are transported with the shoes skidding on the ground, giving the operator excellent visibility, and, even over the roughest terrain, perfect balance is maintained. Shoe transportation eliminates carry strain which other front-end loaders must bear. Another Drott feature, which is standard equipment on the Skid-shovel, is the hydro-spring. A pressure line running from the main lift rams to the hydro-spring puts the hydraulic system under spring tension and reduces hydraulic shocks by two-thirds. **Circle No. 5**

Drum-Up Attachment

An economical hydraulic drum up-ender attachment which permits fork truck operators to pick up, transport, stack and empty heavy drums without leaving their seat, has been developed by *Baker-Raulang Co.* Drums can be rotated 90° for vertical or horizontal stacking, or tilted 45° below horizontal for emptying at any height within the lift range of the truck. The up-ender adds a rotating fifth purpose to Baker's four purpose carriage which already provides standard forks, fork-spacer, an automatic adjusting clamp and side-shifter in one unit. The attachment consists of shoes which are pinned to the forks of the Baker four purpose carriage. Mounted on the shoes are pivoted rubber-faced grab plates. **Circle No. 6**

Coal Barge Unloader

This modern barge unloader, with an average unloading capacity of 1350 tons of coal per hour, contains several features besides its unloading speed that make it efficient. Coal is unloaded from the barge by means of a hoist consisting of an 83-ft long, bucket-type elevator. As the loaded barge is moved slowly past the coal

hoist, each of the continually-moving elevator buckets takes a ½ ton bite from the coal pile and carries it to the top of the unloader where it is dropped through a coal crusher and on to a conveyor. A special feature of the coal hoist is that it can be raised or lowered 38 ft to allow a barge to pass underneath or to compensate for the height of the river and the height of the barge when unloading. *Heyl & Patterson.* **Circle No. 7**

Free Literature

(8) CONVERSION CHART: *The Mayo Tunnel & Mine Equipment Co.* of Lancaster, Pa., has prepared a wall chart, 25x11 in. for the rapid conversion of meters to feet-and-inches or vise-versa. This chart has proved very valuable to those engineers working in foreign countries or who have dealings abroad.

(9) BOLT CUTTERS: *The Manco Mfg. Co.* has published their new bulletin No. 521 illustrating and describing two newly developed designs in cutting tools. The first item listed is a mill type bolt cutter with reversible jaws, Model 30-MCC. This new cutter employs reversible cutting blades—blades may be reversed in the same manner as the double edge blade in a safety razor. This feature, it is claimed, doubles blade life automatically with little increase in cost. The second item shown and described on this bulletin is the new Manco Model 200-A guillotine hand operated hydraulic cutter. Only 21 in. long and weighing only 12 lb, this compact new guillotine is designed to do the same cutting jobs as the 42 in. long, 18 lb bolt cutter.

(10) ESTIMATING BOOK: *The Euclid Road Machinery Co.* has just published a revised and enlarged edition of an estimating book that has been widely used by engineers and estimators for many years. Although the book is intended for use in making production and cost estimates for Euclid earth moving equipment, the estimating methods and formulas can also be applied to equipment of other makes. Part 1 covers job analysis and the method of estimating production and the number of hauling units required for a specific job. The next section deals with cost estimating which includes the hourly cost of ownership and the cost of operation and maintenance. Part 3 contains formulas to determine grade ability, rim pull, engine torque, etc.

(11) OVERLOAD RELEASE: The new Dodge Tri-Matic overload release prevents breakdowns, avoids expensive repairs, insures your production against costly interruptions. Pressure exerted by an excessive load causes a piston to move lengthwise through the unit, activating the mechanism instantly. This movement shortens the torque arm, loosens the belts and cuts off current simultaneously. The Tri-Matic is calibrated for adjustment to the load conditions of any job. It can be set to act at any desired load up to the reducer's maximum capacity. It is easy to reset the Tri-Matic. Just pull the speed reducer back into position. This automatically cocks the release mechanism.

(12) SPEED REDUCERS: New 48-page bulletin describes complete line of De Laval double worm and helical-worm gear speed reducers. Complete data is included on horsepower, output torque and center distances for reductions up to 6400 to 1. Detailed information on how to select double reduction gearing, examples of selection, horsepower rating tables, dimension sheets and complete physical data make this a useful bulletin. *De Laval Steam Turbine Co.*

(13) CONTROL SWITCHES: Two additions to their line of Tellevel automatic bin-level control switches are announced by *Stephens-Adamson Mfg. Co.* in a new bulletin recently released. In addition to the normal-duty Tellevel, heavy-duty and explosion-proof units are now being manufactured to meet special installation conditions. All Tellevels are designed so that a rising, or falling, level of material in bins deflects a pendant float actuating a micro switch. The explosion-proof Tellevel is designed for operation in hazardous areas where explosive vapors and dust occur. Where materials, such as coal, stone and ore with lump sizes above ¾ in. are being discharged to bins, the heavy-duty Tellevel is recommended. This unit is furnished with a sturdy steel housing protecting the switch mechanism and the standard plastic float ball is replaced by a steel cone.

(14) CONVEYORS & ELEVATORS: A new booklet of information on Bulk-Flo conveyors and elevators has just been published by *Link-Belt Co.* and is now ready for distribution. This 28-page booklet contains photographs of the Bulk-Flo in a wide variety of applications, together with typical layout drawings, engineering data, calculation tables, charts and formulas. Over 150 materials are analyzed for average weight and such characteristics as size, flowability and abrasiveness. The conveyor was developed for the mechanical handling of a great variety of bulk flowable materials.

(15) HAND TRUCKS: A 12-page condensed truck catalog has just been released by the *Howe Scale Co.* Specifications and illustrations are shown for the complete line of the latest Howe two and four-wheel hand trucks, trailer trucks, lift jack systems, wheels, casters and molded-on rubber tired wheels. This catalog also shows modern Howe construction features engineered for trouble-free and economical materials handling service.

(16) DITCHERS: Two new catalogs describing the Buckeye Model 314 and Model 303 wheel type ditchers have been announced by *Gar Wood Industries, Inc.*, manufacturers of the Buckeye ditchers. The Model 314 catalog explains in detail the construction and operational features of this pipeline and utility ditcher which features with a fluid coupling for more efficient power transmission and longer service life through cushioning of shock. Other features of the Buckeye 314 described are the hydraulic digging wheel hoist, one-piece digging rims with variable bucket spacing, and flexible-type gear traction drive. The 303, a versatile, medium utility ditcher features ease of accurate operation and efficient power transmission which means more work for less fuel. Like the 314, the Buckeye 303 has a split torque conveyor drive and one-piece digging rim.

Mining Engineering June
29 West 39th St.
New York 18, N. Y.

Please send me { More Information ☐ / Free Literature ☐ / Price Data ☐ } on items indicated.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30

Students are requested to write direct to the manufacturer.

Name ________________ Title ________

Company ________________

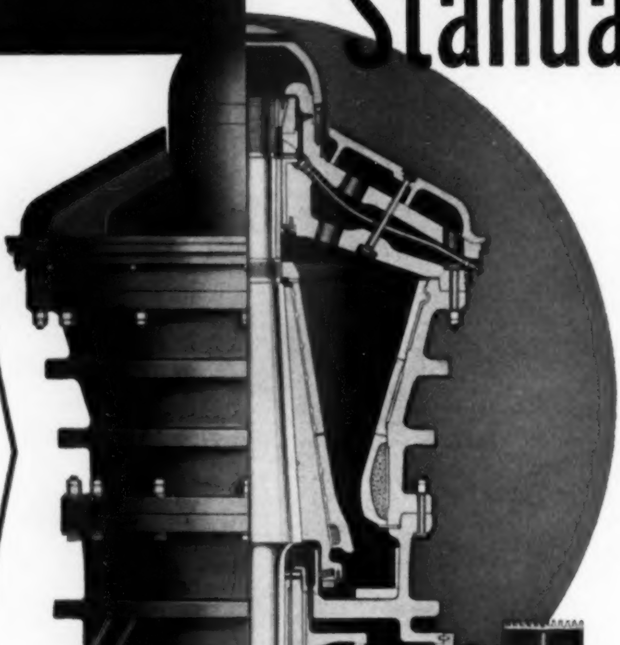
Street ________________

City and Zone ________________ State ________

Setting

New Crusher Standards

Primary & Secondary



Improved lubrication throughout, including spider.

Sturdy all-steel construction . . . with heavy external ribbing.

Greater operating flexibility than any comparable crusher. Eccentric setting and speed can be varied to suit your capacity requirements.

More effective dust seal.

Vertical adjustment compensates for wear and maintains uniformity of product by means of adjustable spider suspension or Hydroset control. This hydraulic control permits quick product size setting and makes it easy to clear crushing chamber after shutdown.

Easy-to-replace, long life bearings.

Free-fall discharge.

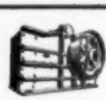
THE *SUPERIOR* CRUSHER — with all these important features — requires fewer manhours to maintain . . . results in less shutdown time . . . less in the way of maintenance. And, whether on primary or secondary crushing, it will produce these savings for years to come. The A-C representative in your area will give you complete, detailed information. Call him, or write: Allis-Chalmers, Milwaukee 1, Wisconsin. A-3648

Superior and Hydroset are Allis-Chalmers trademarks.

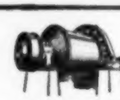
ALLIS-CHALMERS A-C ALLIS-CHALMERS

Sales Offices in Principal Cities in the U. S. A. Distributors Throughout the World.


Hammermills


Jaw Crushers


Gyratory Crushers

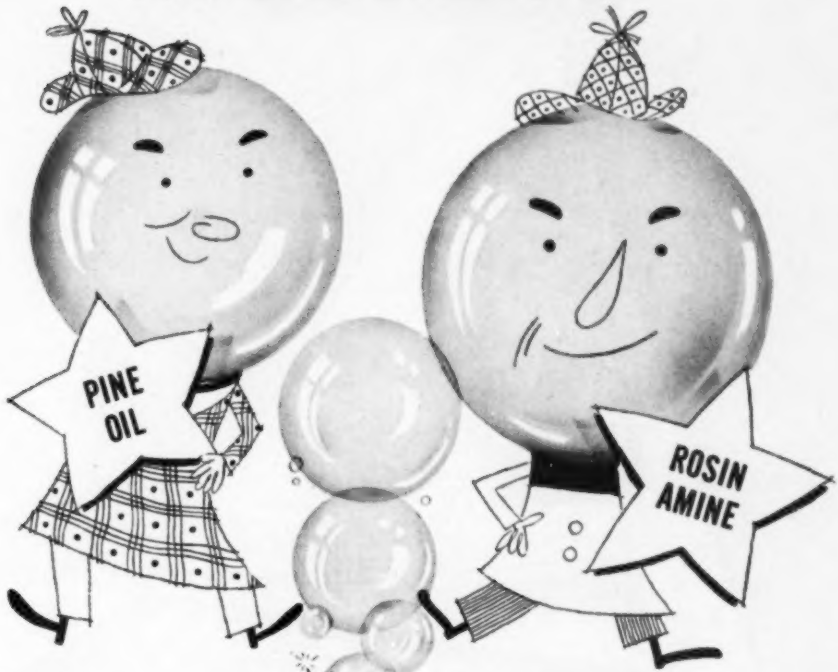

Grinding Mills


Vibrating Screens


Kilns, Coolers, Dryers

Use these "Agents"

FOR BEST RECOVERIES



Frothers

HERCULES YARMOR® F PINE OIL
Standard of quality among pine oil frothers since the early days of flotation. Yarmor F Pine Oil produces a strong froth of good volume, satisfactory texture, and excellent cell-life stability.

Collectors

RADA (Hercules Rosin Amine D Acetate)
Siliceous mineral collector that has good solubility and handles easily.

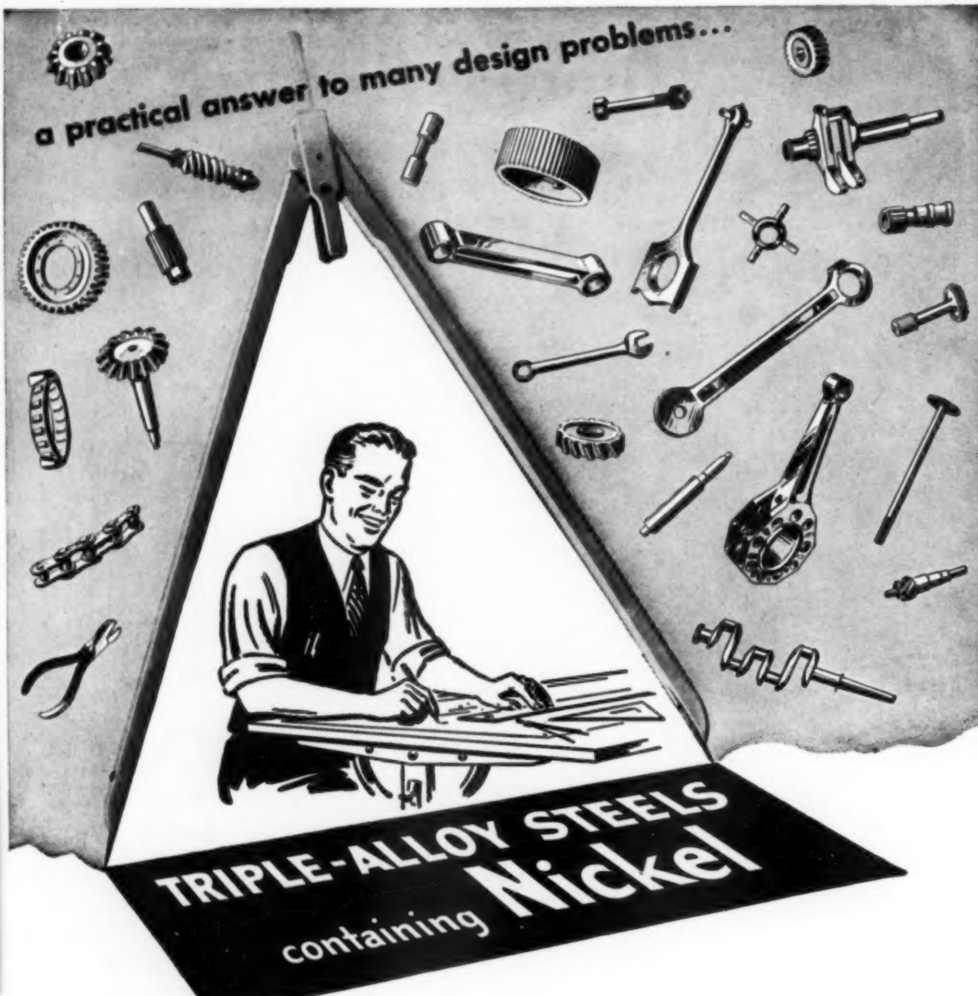
Rosin Amine Derivatives: Special purpose collectors; uses vary with type of materials to be floated.

Technical information on these and other flotation aids is available. Send for 16-page booklet "Flotation and Hercules Flotation Agents."

HERCULES Flotation Agents

HERCULES POWDER COMPANY INCORPORATED *Naval Stores Department, 955 King Street, Wilmington 99, Delaware*

NM52-1



Triple-alloy steels containing nickel offer designers the following *triple* advantages:

1. OUTSTANDING PERFORMANCE—Strength and toughness, resistance to wear, fatigue or shock to meet a wide range of requirements, as dictated by design.

2. RELIABILITY—based on consistently uniform response to heat treatment.

3. ECONOMY—resulting from standard compositions precisely graded to match the engineers' needs.

Service records established by triple-alloy steels over a period of years show that they are giving excellent results in many diverse and exacting applications.

The many standard combinations available permit accurate and economic selection for specific uses.

Because of their many advantages, these triple-alloy steels warrant your careful consideration when planning new or improved designs. We shall be glad to furnish counsel and data upon request.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.

Manganese deposits discovered in Maine may solve one of the problems facing the steel industry today. Diamond drilling is scheduled to start in Aroostock County to determine whether the ore is of acceptable grade. The Bureau of Mines estimates the deposit contains several hundred million tons. If true, it means about a 30-year supply. The steel industry presently imports about 90 pct of its needs.

Noranda Mines, Ltd., is planning a sulphur-iron plant for Ontario's Niagara Peninsula. Although contracts have not been signed, a substantial agreement has been reached with American Cyanimid, Ltd., whereby the Noranda plant would be constructed adjacent to Cyanimid's chemical plant at an estimated cost of $4 million. The unit would treat approximately 100,000 tons of pyrite concentrate annually.

San Manuel Copper Corp., wholly-owned subsidiary of Magma Copper Co., is asking the RFC for a $111.28 million loan for development of a copper orebody in Pinal County, Ariz. The property is said to be capable of producing 10 million tons of ore annually. San Manuel plans to construct facilities for processing 30,000 tons of ore and for smelting 800 tons of concentrate daily.

An Aeromagnetic map covering 120 sq miles of the Wichita Mountain area in southwestern Oklahoma indicates a possibility of iron production from titaniferous magnetite deposits of the Raggedy Mountains, northwest of Lawton. The map shows an area in the north central part of the region which may prove favorable to further development.

Plans are being formulated by United Keno Hill Mines to construct a 250 to 350-ton daily capacity mill at a new mine location on Keno Hill, about 280 miles northeast of Whiteface, Alaska. Presently, the major part of its 450-ton daily base metal capacity is transported 15,000 ft down Galena hill on an aerial tramway. Erection of a custom mill is also being contemplated by Toronto financial interests, for handling high grade ores from four properties already extensively developed in that area.

Pan-Ore Co., a subsidiary of Alcoa, placed an order with Swedish yards for the construction of three ore-carriers. Lindenholmens Works, Gothenberg, will build one 26,000 deadweight ton ocean carrier to be completed in 1955 for use between Trinidad and Mobile, Ala. Two shuttleships of 8000 deadweight each will be constructed for use between the Surinam beds and Trinidad. The ships will be diesel propelled. Another 31,000 ton ocean ore carrier, being built in England for Pan-Ore through its Canadian subsidiary, is turbine powered.

The Yugoslavian news agency Tanjug reported discovery of large chromium deposits containing an estimated 500,000 tons of ore. The discovery, in southwestern Serbia, is in addition to a reported 1.5 million ton reserve, placing Yugoslavia among the leading chromium sources in Europe.

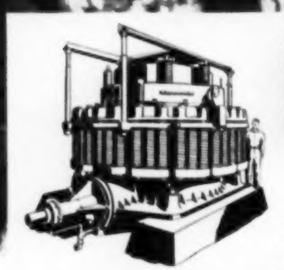
Photo from DeBeers Consolidated Mines, Ltd.

DIAMONDS have been the supreme jewels for centuries—yet the real value of the diamond today is found in its industrial applications, where fully 75% of the diamonds mined are used.

In South Africa, the largest diamond producing region in the world, these *crown jewels of industry* are found deep in the earth, in volcanic rock known as *blue ground . . . and for every ton of blue ground mined, less than ¼th carat is recovered.*

Of prime importance to the major diamond mines of South Africa is a dependable method of crushing the blue ground to the required fineness without destroying the diamond crystals, yet maintaining a minimum cost per ton produced. This important combination is found in the *"SYMONS"* Cone Crusher . . . and extensive installations of these crushers, as well as *"SYMONS"* Vibrating Screens, in the world's diamond mines testify to their ability to maintain, year after year, *continuous high capacity production with uninterrupted, trouble-free service.*

C552



• "SYMONS" Cone [illegible] . . . [illegible] chines that revolution[illegible] . . . are built in Stan[illegible] Short [illegible], and Intermediate type[illegible] crushing heads from 22 inches to 7 [illegible] in diameter —in capacities from 6 to [illegible] per hour.

NORDBERG MFG. CO., Milwaukee, Wisconsin

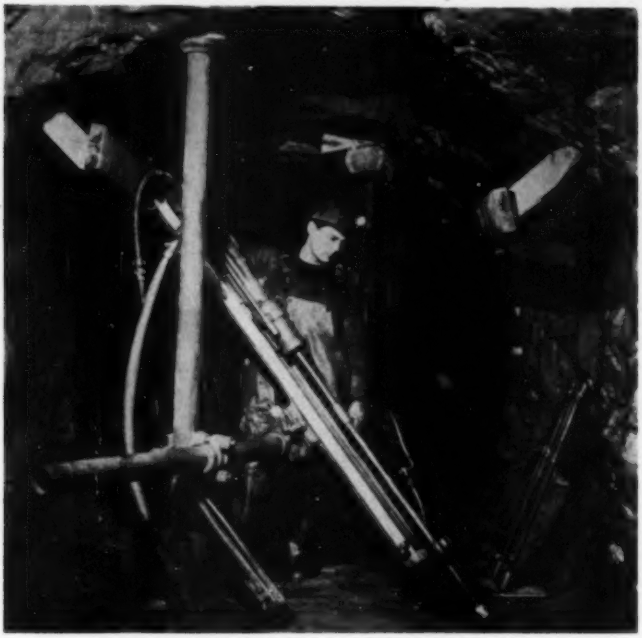
"SYMONS" . . . A [illegible] TRADEMARK KNOWN THROUGHOUT THE WORLD

NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

NEW YORK • SAN FRANCISCO • SPOKANE • WASHINGTON • TORONTO
MEXICO, D. F. • LONDON • PARIS • JOHANNESBURG

Recover Sub-Marginal Ores at Sudbury As Inco Mining Operations Intensify



In blasthole mining, one of five methods used by International Nickel in the Sudbury District of Ontario, rings of holes up to 75 ft long are drilled in the ore and blasted simultaneously to break off a slice of ore containing up to 60,000 tons. Picture shows a typical setup for longhole drilling with tungsten carbide bits.

Utilizing tendencies for low grade ores in the Sudbury District of Ontario to cave after higher grade ore has been mined, International Nickel Co., of Canada, Ltd., is recovering millions of tons of nickel-copper ore once regarded as sub-marginal.

Inco is working lower grade ore than ever mined before from its underground operations because of the caving method and metallurgical practices. In the caving method, blocks containing as much as 1.5 million tons of ore are undercut. As ore from the undercut block is withdrawn, the block to be mined breaks away and starts to disintegrate as it moves downward.

Inco is also using the blasthole method, using explosives to break slices of harder, tougher ore from solid material.

Inco has built a new concentrator at one of its most recent shafts for handling the increased tonnages of low grade ore. The concentrator presently has a 10,000-ton per day capacity, and is scheduled to be increased to 12,000 tons. Hoisting from the mine is by push-button control and the ore is milled on the spot. A 7½-mile pipeline carries bulk concentrate to reduction plants at Copper Cliff.

Giant crushers, weighing 165 tons each, have been installed underground. Twenty-ton electric locomotives haul ore to the crushers.

The expansion program is expected to lift total annual production of nickel in the free world to 375 million pounds annually, an increase of 150 million pounds. Inco is presently mining more than 1 million tons of ore per month from combined surface and underground operations.

Lithium Extraction Method Developed

Extraction of lithium sulphate from two of its four major sources simultaneously is now possible as the result of a new process developed by the Bureau of Mines.

The discovery was made at the Bureau's Rapid City, S. Dak., field station by S. M. Runke, metallurgist-in-charge, and L. H. Kalenowski, a former Bureau chemical engineer. Research in Black Hills pegmatites containing essential minor minerals is in progress at the station.

Lithium, its alloys and salts have a variety of uses developed in recent years, ranging from purifying helium gas by removal of nitrogen, to scavenging molten metals of undesirable impurities, and to welding aluminum.

Lithium is found in many mineral compositions, but only four have commercial importance: lepidolite, zinnwaldite, amblygonite, and spodumene, with the latter the most significant. Because amblygonite and spodumene frequently are found in the same ore, a single process for treating a mixture makes possible increased use of amblygonite as a source of lithium, obviating separation of the two minerals when found together.

The new process is reported to yield recoveries ranging from 66.7 pct to 97.3 pct of the lithium in the ore mixtures. A single set of conditions was determined under which good recoveries could be obtained from either of the two minerals or mixtures of both.

Safety Conference Convenes in Duluth

Duluth, Minn., the nation's biggest iron ore port, was the scene of the twenty-eighth annual conference of the Lake Superior Mines Safety Council on May 22 and 23 at the Hotel Duluth.

Composed of representatives from iron ore, copper and limestone companies, and from the U. S. Bureau of Mines, the Council is dedicated to promoting safety among supervisors and employees. Papers covering various facets of mine safety were presented by industry and government men.

G. A. Borgeson, assistant claims manager, the M. A. Hanna Co., Hibbing, Minn., president of the council for the past year, presided.

City Taking Shape in Wilderness as White Pine Copper Mine Development Progresses

Once again American axes are reshaping the skyline to make room for a city. The town of White Pine is being born in Michigan's Western Peninsula as construction workers clear woodland and begin building homes for about 2500 people who will live on the White Pine Copper Co.'s property a few miles from Lake Superior.

Between 300 and 600 homes will be erected in addition to stores, a hospital, schools, and an office building. As work progresses, other structures will be added. White Pine Copper Co., a subsidiary of Copper Range Co., expects the mine to produce about 75 million pounds of copper annually. Construction of the city is expected to take between 30 and 36 months. Trailer park facilities are also being provided.

Reconstruction Finance Corp. loaned White Pine $57.18 million for construction and installation of equipment and development of the property. Initial working capital and interest on the loan during the construction period will be supplied by Copper Range.

White Pine President Morris F. LaCroix, in appraising the possibilities of White Pine, said, ". . . the exploitation of the White Pine orebody is economically sound and feasible and orthodox and satisfactory mining, milling, and smelting procedures are applicable to the project. The principal metallurgical problems were to find and determine proper size of grinding and conditioning and the most economical combination of the different types of reagents . . . the flow sheet of the mill is simple and orthodox and the physical characteristics of the orebody make it possible to use highly mechanized and generally accepted mining and haulage equipment."

The RFC loan matures in 20 years and carries an interest rate of 5 pct per annum, payable quarterly. It will be subject to a fixed sinking fund starting July 1, 1956, or eighteen months after completion of the White Pine project, whichever is earliest, at the rate of $3 million a year.

U. S. Firm Gets Japanese Contract

An American engineering firm has been awarded a contract for the supervision of the installation of a heavy media coal separation plant in Japan. Much of the equipment will be Japanese constructed, according to the contract.

The contract was awarded to the Southwestern Engineering Co., of Los Angeles by the Yokoyama Engineering Co., of Tokyo.

Southwestern has also been given a contract for the engineering, design and supervision of construction of a 1500-ton per day installation for the production of lead and copper by Uruwira Minerals Ltd., Tanganyika, East Africa at the firm's Mpanda mine.

The American firm will handle design and specification for a mine surface plant, shops, crushing, heavy media, grinding and concentrator sections, laboratories, hospitals and other units.

Launch Sulphur Barge For Service in Louisiana

A barge designed for transporting sulphur from the Freeport Sulphur Co.'s new mines in Louisiana marshlands to Port Sulphur was launched at Avondale Marine Ways in New Orleans.

The barge is the first of six projected by Freeport as part of an expansion program expected to increase production by 575,000 tons annually. The barge measures 225 ft by 39 ft and has a carrying capacity of 1000 tons of liquid sulphur in an insulated tank. Sulphur can be kept in a molten state in the barge for three to four days.

Freeport sulphur produces about 1.25 million tons of sulphur annually at its Grande Acaille mine. Two Texas mines account for an additional 400,000 tons. If Freeport gets the production it expects from its two new Louisiana mines, it will be producing about 40 pct of today's entire U. S. production.

Canadian Aluminum Output Hits Record

Canadian Aluminum output reached a seven-year high in 1951, in the face of increased demands from the world market. New investments in expanded plant facilities totaled $120 million, according to Nathanael V. Davis, president, Aluminum Ltd., Montreal.

Aluminum Co. of Canada smelters increased production from 396,000 U. S. short tons to 446,000 tons. Alcan also reopened its 35,000-ton smelter at Beauharnois, P. Q. Aluminum shipments in all forms by wholly owned subsidiaries of Aluminum Ltd., totaled 477,000 U. S. tons compared with 441,000 in 1950.

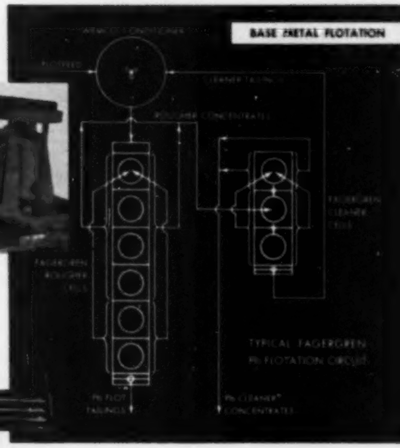
Government controls in Canada, United States, and the United Kingdom, where 88 pct of the output was marketed, channeled a large percentage of production into defense uses. Increased demands in other markets also were felt. However, only a small part of the wants of South America, Continental Europe, Africa and Asia could be satisfied by the company. The expansion program, according to Davis, is aimed at putting the company back in a position where it can meet the needs of its customers.

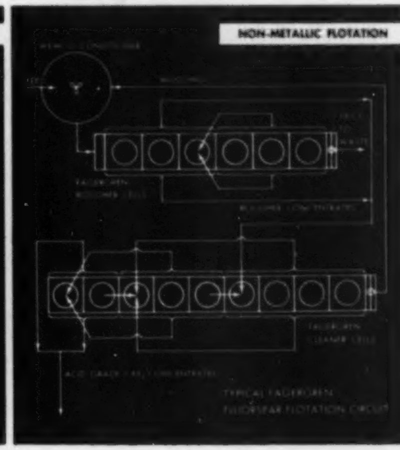
The 1951 expenditures are part of a $360 million program planned for the period 1951 to 1954. One program is being carried forward in Quebec and the other in British Columbia. The Quebec expansion is expected to increase production about 550,000 tons of aluminum ingot per year. In British Columbia, the first of a series of smelting and hydro-electric facilities are under construction. First production is expected in 1954, with an estimated 500,000 tons annually to be produced eventually. Other new mining and processing installations are being constructed in Jamaica, French West Africa, and British Guiana.

Taconite Development

Bucking the wilderness, an International TD-24 crawler tractor bulldozes an access road in Reserve Mining Co.'s big new taconite development at Babbitt, Minn.

These Flotation Flowsheets prove it!





FAGERGRENS give greater flexibility of cell arrangement!

These typical flowplans demonstrate the outstanding features of WEMCO's Fagergren Flotation machine: flexibility of cell arrangement. Fagergren cells are arranged for product transfer by gravity flow, on one floor level and **without the use of auxiliary pumping equipment.**

In medium size and small circuits, Fagergrens provide high metallurgical efficiency in cleaner, recleaner and rougher operations by recirculation of flotation products. This efficiency and the unequaled flexibility of cell arrangement give you these seven advantages:

- *low installation cost*
- *low operating cost*
- *high metallurgical efficiency*
- *large capacity*
- *minimum attendance*
- *minimum maintenance*
- *low reagent cost*

Write today for further information on how Fagergren flexibility can improve your flotation results.

OTHER **WEMCO** PRODUCTS

*Mobil-Mills • Coal Spirals • HMS Thickeners
HMS Pumps • Densifiers • Cone Separators
Drum Separators • Fagergren Laboratory Units
Fagergren & Steffensen Flotation Machines
Hydroseparators • HMS Laboratory Units
Dewatering Spirals • Agitators • S-H Classifiers
Thickeners • Sand Pumps • Conditioners*

WEMCO
WESTERN MACHINERY COMPANY
760-766 FOLSOM STREET · SAN FRANCISCO 7 CALIFORNIA

For the War Against Wear in the Fight for Economy

AMSCO

Manganese and Hardfacing Rods

AMSCOATING

THE RIGHT WAY TO SAY HARDFACING

Immediate Delivery

Impact and abrasion are always at work but their effects can be postponed through the use of AMSCO Welding Products. Reclamation and rebuilding of worn or damaged equipment parts by Amscoating means dollar-saving, long-lasting protection. The AMSCO Hardfacing System successfully fights wear caused by impact, abrasion, heat or corrosion. It assures longer equipment life and fewer repairs.

For prompt delivery of these welding products, contact your AMSCO distributor.

AMSCO AW-79 will meet every requirement for better control of wear where abrasion and impact are important factors—plus all the advantages of automatic welding. Especially suitable for rebuilding and hardfacing tractor rollers, steel wheels, sheeting rails, dredge pins as well as dozens of other applications. 1/8" and 3/16" in 22½" I.D., 100 lb. coils.

AMSCO No. 459 for severe abrasion, mild impact. Has excellent abrasion resistance. All diameters, bare and coated.

AMSCO No. 217 for abrasive service up to 1100° F. The deposit retains hardness at high temperatures. All diameters, bare and coated.

AMSCO No. 6 for combination of corrosion or abrasion, or for 1000° service and above. Used as facings for tool and die applications. No. 1 has greater abrasion resist-

This Wall Chart can save you money. Listing over 20 common hardfacing applications, it recommends the right AMSCO rod to use and the preferred method of application. Write for this free wall chart guide today.

AMERICAN Brake Shoe COMPANY

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis.

WELDING PRODUCTS

Manganese Steel Bars and Shapes

CONTROLS IMPACT and ABRASION

Through many years' experience in the production and application of manganese steel—"the toughest steel known"—AMSCO has developed welding products designed solely to conserve and protect parts exposed to impact and wear. American Brake Shoe Company's scientists and engineers are working continuously to build better defenses against wear in machines and equipment.

AMSCO Welding Rods are known for their excellent service in many applications—from rock crushers to materials handling pumps . . . in forging, rolling, stamping, and cutting . . . for gears, sprocket wheels and clutch cams . . . in grinding, mixing, and chipping operations . . . Whatever your problem of wear, there's a "proved-in-service" AMSCO Hardfacing Product that can solve it.

ance; No. 6 is the tougher, and can be machined. All diameters, bare and coated.

- **AMSCO No. 1** for combination of corrosion or abrasion, or for 1000° service and above. Used as facings for tool and die applications. No. 1 has greater abrasion resistance, No. 6 is the tougher, and can be machined. All diameters, bare and coated.
- **AMSCO FARMFACE or AMSCO CHROMEFACE** for industrial and farm use. Deposit has excellent resistance to low stress sliding abrasion. All diameters, bare and coated.
- **AMSCO AIR-HARDENING** for abrasion and severe impact. Deposit can be forged to a sharp edge without losing hardness. All diameters, bare and coated.
- **AMSCO HF-40** for severe abrasion and moderate impact. Deposits of HF-40 are hard and abrasion resistant. All diameters, coated only.
- **AMSCO HF-60** for moderate impact and severe abrasion. This rod is particularly suitable for application in both flat and vertical positions. All diameters, coated only.
- **AMSCO CO-MANG** for build-up on manganese steel castings exposed to severe impact. Deposit has excellent impact resistance. All diameters, coated only.
- **AMSCO TOOLFACE** for metal to metal wear up to 1000° F. Toolface deposits have excellent abrasion resistance. All diameters, bare and coated.
- **AMSCO DIEWELD** for tools and dies. Deposit may be softened for machining and rehardened. Retains a keen cutting edge.
- **AMSCO V-MANG** for build-up on manganese castings exposed to impact.
- **TUNGSTEN CARBIDE.**

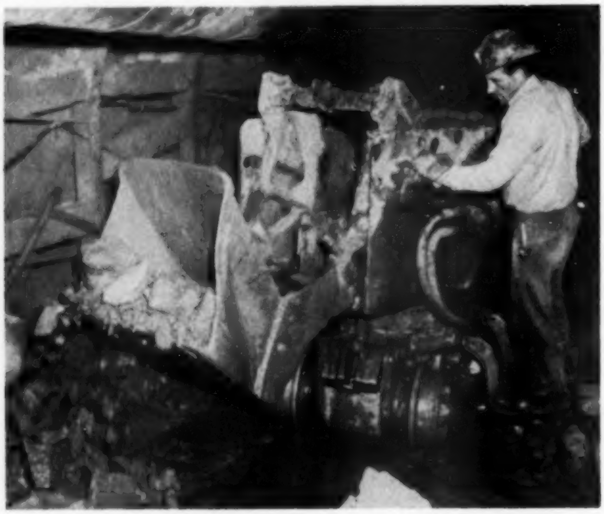
A complete line of manganese steel dipper tooth repointer bars and other shapes are available.

AMERICAN MANGANESE STEEL DIVISION

417 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

In Canada: Joliette Steel Division, Joliette, Que. Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

Set World Tunneling Record of 111 Feet In 24 Hours at Colorado Electric Power Project



Mucking operation is carried out during 24 hr period when world record for tunneling was set at the North Poudre Supply Canal job. The work is part of the Big Thompson project in Colorado.

A new world's tunneling record of 111 ft in 24 hours was established at Tunnel No. 4, North Poudre Supply Canal, part of the Big Thompson irrigation project in Colorado.

Tunnel No. 4 is approximately 3500 ft long. Its size is 9 ft 4 in. rough horseshoe and 8 ft finish, semi-elliptical. The rock formation consists of Sundance sandstone, Lykins formations. About 50 pct of the tunneling was through this formation with the remainder going through shale.

Thirty-six holes per round were drilled, with 13 rounds to pull the 111 ft. Five drills were used, on the jumbo four at the face and one spare. Contractor for the job is the G. L. Tarlton Contracting Co.

Haulage cars used were 90 cu ft, Granby type, with model 21 Eimco loaders employed.

U. S. Demand Starts Quebec Base Metal Boom

Val D'Or, P. Q., is becoming the scene of a mining rush which promises to surpass the old gold fever days, according to many authorities in the area. The discovery of large amounts of base metals and the demand for them in the U. S. has brought a new crop of prospectors and mining companies to the region.

Base metal production has risen to 163,000 tons worth $75 million, compared with 1.061 million ounces of gold at $39 million. In 1942 gold production was valued at $42 million while other metals brought $17 million. East Sullivan Mines, Ltd., went into base metal production in 1942 and reportedly has shown a net profit of $6 million annually.

The lead, copper and zinc boom has boosted the population from 6000 to 10,000 in three years. Possible tonnage has been placed at 480 million tons, with only about 30 pct of the area thoroughly investigated.

Continue to Extend Steep Rock Orebody

The length of the G orebody of Steep Rock Mines, Inc., in Ont., Canada, has been increased 50 pct by drilling. With exploration still incomplete, indicated ore on the G zone has been extended to 4500 ft, with an indicated width of 450 ft.

Julian Cross, mining engineer, who discovered the Steep Rock deposits, said he believes that the Hogarth and Errington mines and the intervening G zone actually are one continuous orebody almost three miles in length.

He estimated that production from the single portion can be maintained at 6 million tons annually for many years. Double that tonnage can be expected when the range is fully developed, he said.

Automatic Hoist Installation at Freeman

The new crown mine of the Freeman Coal Mining Corp., at Farmersville, Ill., has the first high-speed, balanced, automatic mine hoist ever to be installed in the nation's coal fields.

The 1000-hp dc hoist is designed to lift 800 tons of coal up a 491-ft vertical shaft every hour. The rated rope speed is 1357 fpm. The hoist was constructed by the Vulcan Iron Works of Wilkes-Barre, Pa. It will use two skips, each weighing 7½ tons and having a pay load capacity of eight tons. The General Electric amplidyne - controlled, adjustable speed drive is made up of a 1000-hp, 500 rpm, dc drive motor and a 750-kw MG set consisting of a 4160-V synchronous motor and a 500-V, dc generator.

Montana Chrome Mines Reopen With U.S. Support

Production is expected to begin within a year at the Mouat Mines, Stillwater County, Mont., under contract between the Defense Minerals Procurement Agency and the American Chrome Co.

The deposits are reported to contain about 80 pct of the nation's chrome ore. American Chrome has agreed to supply 900,000 tons of chrome concentrates during an eight-year period. Basic price to be paid for the product, which must contain 38 pct chromic oxide, is $34.97 per ton.

Development of the property, including construction of plant facilities, housing, streets, utilities and other improvements, began early in World War II. It was abandoned when sufficient supplies were available abroad.

The company will supply $950,000 working capital, and the Government will advance a similar amount against future production, at 4 pct interest. The government will also supply up to $1.811 million worth of equipment on a loan basis.

Belgian Firm Ships Nevada Ore to Japan

Iron ore mined at Lovelock, Nev., is being shipped to Japan by the Brussels Corp., a Belgian firm owned by the Bank of Belgium. The ore is being sold to Miayko Shoji Kaisha, a Japanese trading firm.

A total of 275,000 tons have been arranged for, with the first lot loaded at Stockton, Calif., early in May. Four vessels a month are expected to carry the ore to Japan. Heavy shipments to that country have been in progress for some time. Howard Terminal, Oakland, con-

tracted to handle some 250,000 tons recently.

Shipping officials estimated a million tons will move through San Francisco, Oakland, and Stockton this year. Japan formerly obtained large quantities of ore from Manchuria, a source of supply no longer open.

Largest Underground Power Plant Being Built

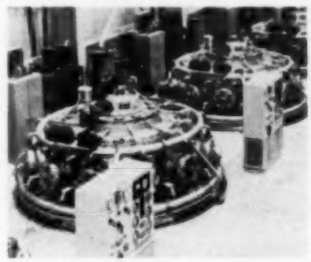
The Nechako-Kemano-Kitimat hydro-electric plant under construction at Kittimat, B. C., adjoining an aluminum reduction plant, will be the largest underground power development in the world when completed.

The plant will have an annual firm energy generation well in excess of the estimated 8,100,000,000 kwh firm from Grand Coulee, according to F. L. Lawton, chief engineer, Power Department, Aluminum Laboratories, Ltd. In addition, Kittimat is located in a low cost transportation area.

Ultimate firm delivery is expected to reach 1.67 million hp. In addition to the power plant, aluminum reduction development and port, a townsite for 50,000 inhabitants has been selected. The reduction plant is being built on the delta of the Kitimat River, partly on alluvial sands deposited on the edge of the delta. Heyl & Patterson, Inc., will construct the carloading house to which the belts will bring the ore.

Point Comfort Smelting Capacity Climbs to 70 Pct

Aluminum smelting capacity at Aluminum Co. of America's Point Comfort plant has been increased 70 pct by an addition to its gas-fueled power generating facilities. The largest internal combustion engine generating station in the world, it now has a total engine rating of about 350,000 hp.



View of the new Point Comfort installations which have increased capacity by 70 pct.

The increase is expected to give the Point Comfort plant an aluminum producing capacity of 85,000 tons annually. The original three-building power plant had 120 engine-generator units. Seventy-four new units have been installed.

The 194 engines have a 14-in. bore and a 16-in. stroke and employ a dual spark ignition system. All were built by Nordberg Manufacturing Co., and are of the two-cycle, radial type.

Penn. R. R. Ore Pier Construction Starts Soon

Construction on Pennsylvania Railroad's ore unloading pier at Greenwich Point in South Philadelphia, on the Delaware River, is practically set to begin.

Contracts have been signed for machinery to operate the pier and preparatory work has progressed considerably. Hundreds of the 1210 reinforced concrete piles to be driven into the river bed have been assembled. Dredging operations have been completed to 850 ft from the shoreline. The pier is being constructed just north of Pennsylvania's coal dumper. Yard tracks, switches and other facilities are being installed as support for the operation.

TY-ELECTRIC HEATED TY-ROCK SCREEN

"for efficient screening of damp materials"

INCREASE PRODUCTION
•
REDUCE LABOR COSTS

Send us the details of your damp screening problems so our Engineering Department can make recommendations.

Ty-Rock Screen with Ty-Electric Heating System.

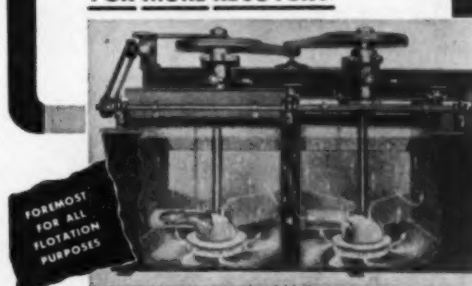
THE W. S. TYLER COMPANY
CLEVELAND 14, OHIO ★ U. S. A.

Canadian Plant—St. Catharines, Ontario, Canada

Specify . . .

MORSE "Jetair" Flotation

FOR MORE RECOVERY



- GREATER AIR COVERAGE and INCREASED RECOVERY assured through complete dispersion of air at impeller periphery.
- HIGHER GRADE CONCENTRATE and substantial reduction in reagents.

Supplied with or without individual cell weir controls.

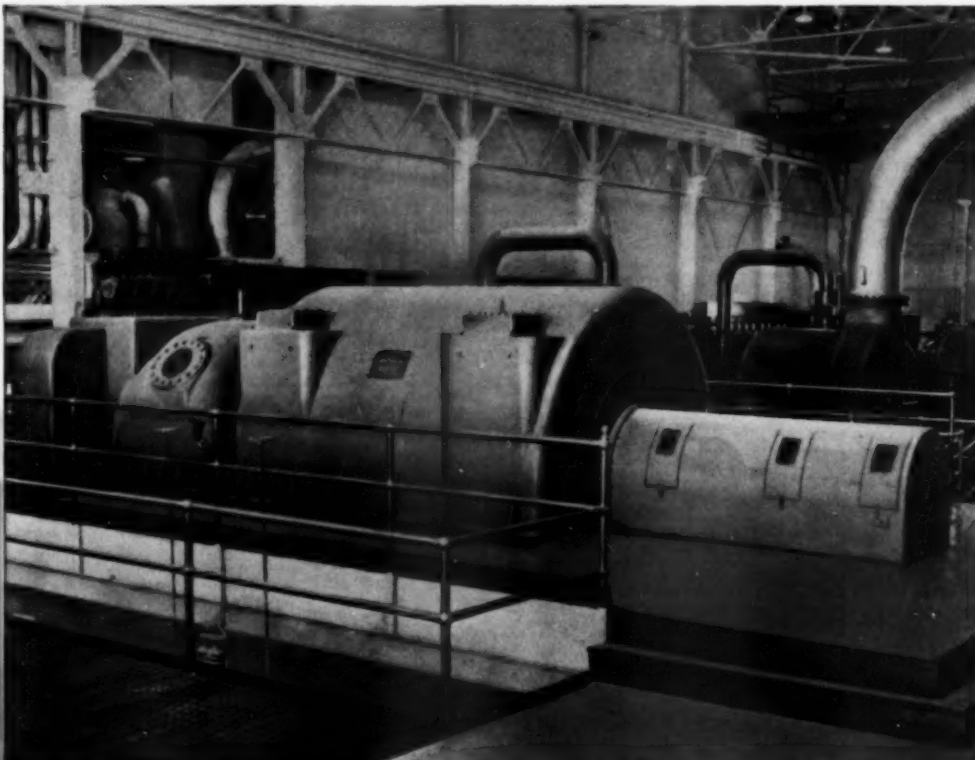
- Rich Froth Zone.
- All Pulp Contacts Each Impeller.
- Controlled Air—Thorough Aeration

MB

Write for Bulletin No. 482

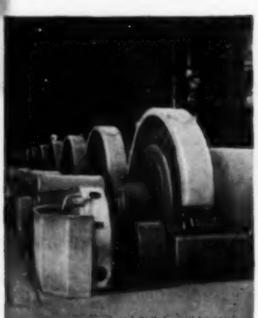
MORSE BROS. MACHINERY COMPANY

DENVER, COLORADO, U.S.A. (CABLE MORSE)



NEW G-E STEAM TURBINE-GENERATOR generates high-voltage power for this copper company's concentrating and smelting plant. Rated at 10,000 kw, 3600 rpm, the single-stage unit replaces an older 6000-kw unit which generated at 480 volts. Like every G-E turbine-generator, it is custom-built from standard components to meet specific operating conditions.

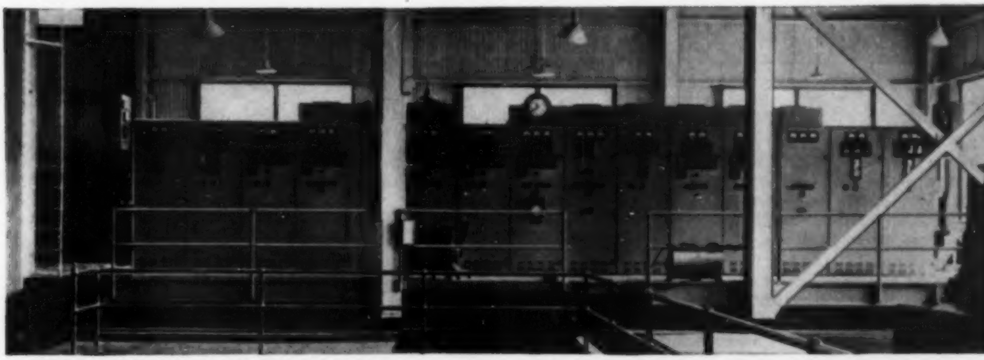
Power system modernized for



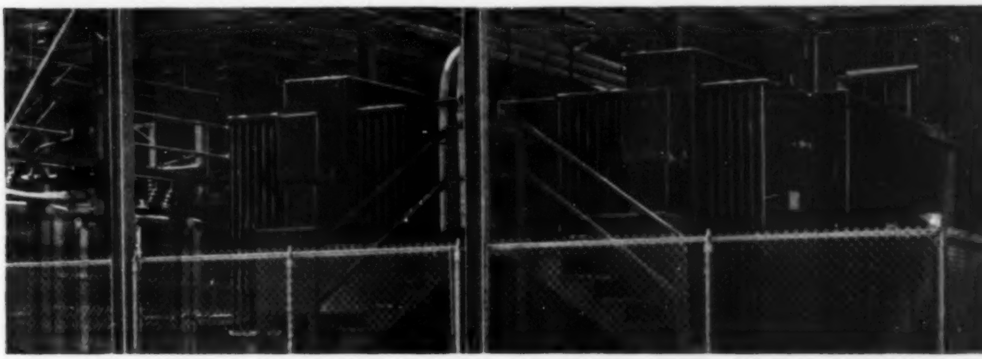
POWER-FACTOR IMPROVEMENT is provided by 28 200-hp synchronous motors driving plant's ball mills.

MECHANICAL POWER to drive two turbo-blowers is generated from process steam by 1915-hp G-E mechanical-drive turbines.

LOW-COST HAULAGE from the copper plant's open pit mine 15 miles away is provided by these two G-E 750-volt 85-ton electric locomotives.



2 **NEW G-E METAL-CLAD SWITCHGEAR** distributes high-voltage power to load-center substations in electrical load areas. These co-ordinated units are shipped completely assembled and ready for installation. Their compact design saves floor space.



3 **NEW G-E LOAD-CENTER SUBSTATIONS,** completely metal-enclosed, step down power from primary voltage to 480-v for use in the ball mill area. High voltage power distribution to load centers reduces voltage drop and cuts power losses.

more efficient distribution

Copper plant increases capacity by adding G-E turbine, switchgear and load-center substations to existing power system

As part of a continuing modernization program at its concentrating and smelting plant, a large copper company in the Southwest recently installed new General Electric high-voltage power generation and distribution equipment. With these new facilities, power is generated and distributed the modern, high-voltage way. Result: increased protection against shutdowns, lower power-distribution cost.

You, too, can benefit from the kind of G-E application engineering that went into this installation. Call your nearest G-E office and ask for a mining specialist. *General Electric Company, Schenectady 5, New York.* 660-25

Engineered electric systems for the copper industry

GENERAL ELECTRIC

Mining Engineering Trends

BOLIVIA'S recent revolution, by hindsight, seems to have been inevitable. The misery of the majority of the people, coupled with the economic crisis engendered by the refusal of the United States to meet Bolivian *demands* for a higher tin price, gave the National Revolutionary Movement party all the excuse it needed for overthrowing the government. Most of the mines in Bolivia are owned by three families. Precisely what it will mean to the United States is still a moot question. Argentina, with a mixture of Marxism, Fascism, and few twists created by the Perons, is in a position to grab off much of the tin we need. Because of the contingencies of geographical location, language and a natural *simpático*, Argentina may be able to continue its efforts to oust the United States from its South American markets.

Point Four aid was supposed to be given to Bolivia, but only for agriculture. Even this was entirely too slow. Mining, Bolivia's other major source of income was forgotten by the Washington planners. Primary aim of the new power will be to diminish its dependence on the world tin market. At a time when the free world is fighting a battle for control of metal, it stands a chance of losing an important source of supply. With the accent placed on agriculture and other industries, mining in Bolivia is certain to suffer. Argentina will be in a position to get the available supply of tin, make a strong ally in the world order of things, and add to its power play against the United States in South America.

Ten labor groups have formed the Bolivian Central Workers Union. The first item on their list for immediate action is the nationalization of the mining and railroad industries. They also came out for agrarian revolution and diversification of industry. President Victor Paz Estenssoro has promised to appoint a committee for the investigation of nationalization of the mines. At least, this is indicative of a feeling for the need for caution.

CHILE compounded United States' woes in South America by canceling the copper agreement between the two nations. The Chilean government is taking over the industry and will attempt to sell the metal on the world market for 33 cents a pound. Under the pact, Chile sent 80 pct of its output to the United States at 27½ cents, and sold the rest for what the traffic would bear. At one time copper prices were as high as 50 cents per pound, but in the last few months there have been some indications that the shortage may be eased considerably compared to the situation as it has existed. The United States represented a guaranteed market for the Chileans, but at the same time certain quarters felt that the disparity between the contract price and the world market price was great enough to support the South American claim of pretty sharp dealing on the part of the United States. At a time when the U. S. must keep its South American friends, it seems to be losing them by the carload. Soviet Russia undoubtedly would like to grab off a large chunk of South American trade if it can, and this may be an opportunity for Mother Russia to extend her little family circle.

With the U. S. on a buyers' strike, Chilean copper is piling up on the docks. Someone with the right price is going to come along and take it away.

DEBATE over the economic feasibility of gasoline manufactured from coal rages on, traveling its merry abstract way. A New York engineering firm has entered the lists with the statement that gasoline made from coal can be made to sell for as little as 11 cents a gallon. Which of course, is in direct opposition to the stand of the National Petroleum Council. The NPC states a price near 41 cents a gallon would be closer to the truth. The New York firm says, however, a price of 15.7 to 17.6 at the refinery would be necessary to finance a manufacturing plant. The Bureau of Mines supports the latter contention.

CONGRESS is still kicking the St. Lawrence Seaway around, but for the first time in 30 years it appears that the fencing may stop and concrete action taken. Leaders in both houses are committed to passage of a bill which would authorize a joint United States-Canada building project. Speaker of the House Sam Rayburn (D.-Tex.) thinks it will reach the house floor sometime during the current session. The Senate Foreign Relations Committee has sent a bill to the Senate authorizing the combined project. It went to the chamber without a blessing, however. A 6-6 tie vote defeated a move to place the committee on record in favor of the project. The project is viewed as a vital need right now, and not tomorrow, by a good many observers. As far as the United States is concerned, it ties in with a necessity for finding some economic means of transporting iron ore from Labrador and other foreign sources to western plant areas.

Total cost to the United States is fixed at $566.79 million. Revenues from an estimated 45 million tons passing through the Seaway annually would accrue to the United States. In addition, there would be a share of electric power equaling 6.3 billion kw per year. Combined revenues, it is estimated, would pay off the total investment in 50 years.

Every presidential candidate in the last 30 years has advocated the project. Some have even made concrete moves in its favor. Canada is definitely fatigued with United States dalliance, and if U. S. doesn't go along this time, its northern friend intends to take the ride alone—and soon.

IT would seem that better foreign relations are not going to begin in British coal mines. Attempts to introduce Italian miners into the English pits have met with almost complete failure. The National Coal Board searched around for the reasons, but the only answers they came up with hardly made good sense. Some of the miners are said to have objected to the Italians because they ate garlic. Others looked down at them as ice cream merchants. Language barriers were also given as a reason for 111 of 159 local miner's lodges refusing to allow Italians into their pits. The Coal Board, taking into account that Britain dug 5 million more tons in 1938 than it did in 1951,

and that in 1938 there were 781,000 miners compared with only 700,000, thought it had the answer. Some of the miners may have objected to Italians for fear of jeopardizing their jobs. But with Continental Europe needing coal at an ever increasing rate, there seems to be no danger of the market drying up. In the event that the market should become saturated, it is more than likely that the United States would suffer rather than Britain. Also, the colliery workers were promised that Italians would go first if layoffs should become necessary. The experiment has been brought to a close and Britain will have to find some other way of getting coal out of the ground.

In the meantime, denationalization of the iron and steel industry is supposed to rear its head sometime this spring—that is if the House of Commons manages to get around to it. Of course, the Laborites have promised to re-nationalize the industry if they ever get to power, so some sort of compromise will have to be worked out. It is doubtful that a complete return to free competition will be possible. The bill, as written by the incumbent Conservatives, will be probably a kind of middle-of-the-road thing, attempting to assure private capital that their investments are safe and at the same time keep the Labor Party happy. The steel shortage continues, with some hope that supplies for home consumption will increase, but lack of coke will continue to plague pig iron producers.

SPRING, sunshine, and increased scrap collections seem to be the only bright spots in the nation's steel picture these days. Baled steel scrap sold below OPS ceilings on the West Coast and the Mid-West showed signs of getting scrap inventories into something like reasonable shape. Scrap trading has increased to a great extent, with both brokers and dealers active. Much of the trading is based on the belief that steel production will continue for a reasonable time.

THERE may be some reason to believe that Maurice Tobin's title should be changed to Secretary *to* Labor, from Secretary *of* Labor after his speech in Philadelphia at the CIO Steelworkers' convention. Tobin told the CIO delegates "I don't feel any obligation to be impartial anymore." He supported his statement by saying since the CIO had accepted the WSB recommendations and management had rejected them, he felt justified in giving the union a blanket endorsement of their position. Some might feel that Tobin has departed from the usual standards set for a member of the cabinet. Critics of the statement feel that it can be explained most charitably by saying, "after all this is an election year, and there were a lot of votes in Philadelphia that day."

MEXICAN mineral production decreased in size, but made up for the loss in dollar value returned. Total value from mining and metallurgical products in 1951 reached 2,424 million pesos from 870,315 metric tons of minerals including gold, silver, copper, lead, zinc, graphite, mercury, iron ore, manganese, cobalt, cadmium and bismuth. Iron led the parade in volume with 312,580 metric tons produced with a value of 43 million pesos. Lead was the second most important mineral produced.

IRVING S. OLDS, retired president of United Steel, recently had a few things to say about inflation. He told the Academy of Political Science, a group not easily misled in matters of money, men and history, that the United States is facing the fate of every country which has allowed its economic policies to run wild on the wings of the imagination of a few men who sit in the governmental saddle. Olds said the disease of inflation hits when government income is incapable of meeting expenditures. It has been said before. Perhaps it has been said so often people no longer listen to it. It may be that the unfortunate aspect of the present trend toward circus type economics is that the truths discovered by the classical economists are no longer believed.

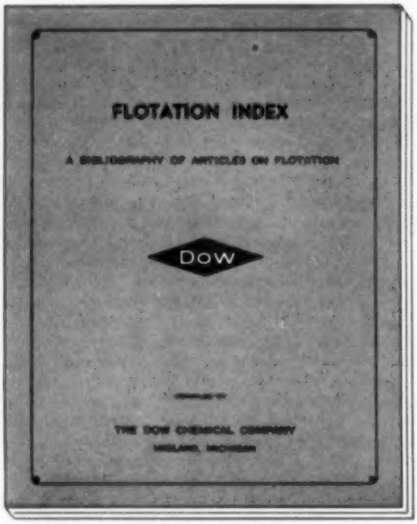
Olds noted that for at least "4000 years economic witch doctors" have been called upon to work the miracle of economic health and have always come up with the same idea—spending our way back to solvency. He charged that the inflationary trend is government planned—starting with devaluation of the dollar in 1933. He praised the oft maligned Eightieth Congress as a body which at least made an attempt at starting the country off toward a sensible fiscal policy. He noted that by 1949 the cost of living had started to decline and persons living on fixed incomes were in somewhat of a better position.

He traced the source of inflation to government and pointed to it as the place where it must be stopped. Olds noted that the second most important step is to increase the tools of production. Capital must be liberated from the tax burden in order to meet the need of the nation for goods, both military and civilian.

Olds said nothing which has not been voiced many times before. But at a time when the citizenry is subject to a variety of misinformation, half truths, and outright deceits on the part of all concerned, one must give consideration to the truth or falsehood of what he has said. If the situation is as he describes, and many authorities side with him, the time may have arrived for a dramatic awakening on the part of the country—before it misses the boat and ends in the sea.

NATIONAL LEAD CO. has acquired a majority interest in Nickel Processing Corp., operators of the Government-owned nickel plant in Nicaro, Cuba. It has been indicated that National Lead and Fomento Minerales de Cuba purchased the interest held by N. V. Billiton Maatschappij in the plant and certain processes which may expand the output. Jess Larson, administrator of General Services, announced the reopening of the plant in February. During the last war, it made vital contributions to the nickel supply.

ANNOUNCING



22nd annual additions to the FLOTATION INDEX

To maintain the most complete authoritative guide to published material on the flotation process . . . request our twenty-second annual supplement for your FLOTATION INDEX. Many of the listings and descriptions of books and articles in the 1952 compilation are of particular note.

DOW XANTHATES

THE DOW CHEMICAL COMPANY • Midland, Michigan

Pioneer Producers of Xanthates for Metallurgical Use

The Dow Chemical Company
Midland, Michigan

Please send me________copies of the 22nd Annual Supplement to bring my DOW FLOTATION INDEX up to date.

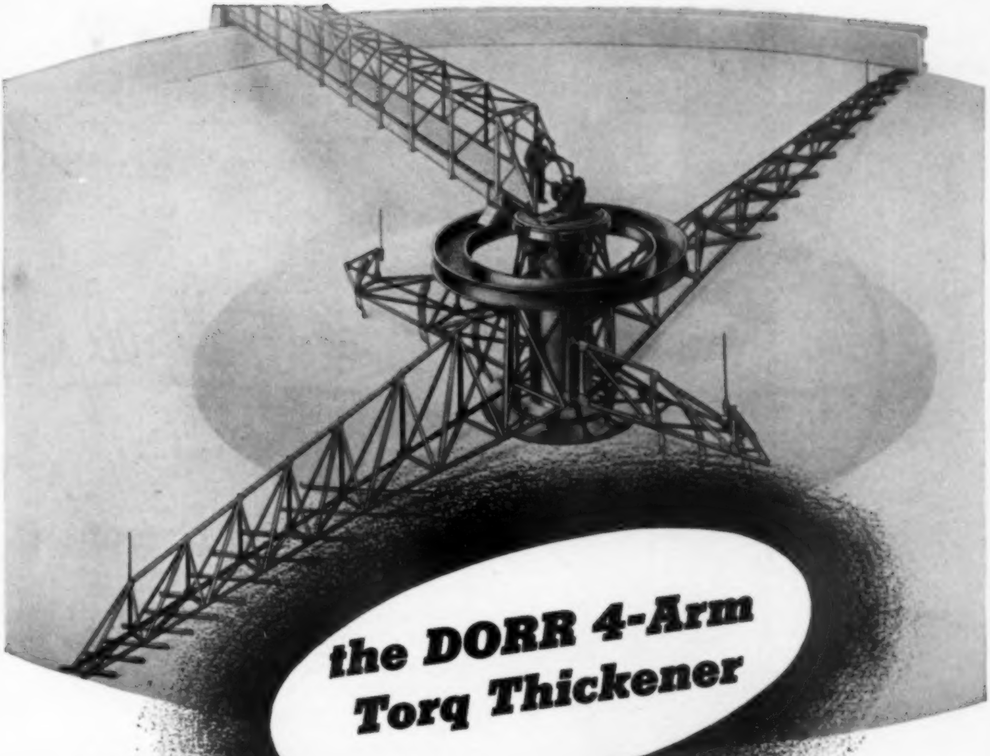
Name____________________

Address____________________

Firm Name____________________

Position____________________

Ask for your copy Simply fill in the coupon and mail



the DORR 4-Arm Torq Thickener

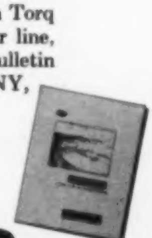
Makes lighter Work of HEAVY Ore Tailings

To handle heavy granular solids subject to widely fluctuating feeds — note the 4-arm feature of the Dorr Torq Thickener.

Two long arms rake the outer section of the tank floor. The two short arms handle the load in the inner section, raking all the solids to a conventional center-cone discharge. All four arms are provided with the exclusive Torq feature . . . which reduces overload by continuous raking action . . . eliminates the danger of stalling and damaging the unit.

For more information about the mechanical advantages of the 4-Arm Torq and the complete Dorr Thickener line, ask us to send you a copy of Bulletin No. 3001. THE DORR COMPANY, Barry Place, Stamford, Conn.

Torq is a registered trademark of The Dorr Company.



Better tools TODAY to meet tomorrow's demand

DORRCO

DORR

WORLD - WIDE RESEARCH · ENGINEERING · EQUIPMENT

THE DORR COMPANY · ENGINEERS · STAMFORD, CONN.
Offices, Associated Companies or Representatives in principal cities of the world.

centralized controls...

for efficient operation

One of the outstanding advantages of the G-300 WAGON DRILL is the convenient grouping of drill, feed and blowing throttles.

G-300 Wagon Drill

- designed to take full advantage of the high drilling speed and strong rotation of the CP 4-inch 70-N Drifter.
- rugged, tubular chassis and drill carriage provides rigidity and strength without unnecessary weight.
- adaptable for all types of wagon drill work. Wheels can be turned at right angles to facilitate line drilling or drilling close to a ledge or wall.
- tubular "H" drill support gives greater stability than the conventional design and minimizes vibration.
- exceptional load-carrying capacity is made possible by the specially designed feed motor and cone-gear drive.

Fiftieth Anniversary

Write for further information.

CHICAGO PNEUMATIC TOOL COMPANY

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

MINING ENGINEERING

EDITORIAL

DE-EMPHASIZING THE ENGINEER SHORTAGE

THERE has been a lot of talk about the shortage of engineers and we have done our share of it; but recently we heard a spot radio commercial—between broadcasts—urging high school seniors to study engineering. We think this is going too far. Engineering is an exacting profession requiring the highest personal qualifications. Publicity for the purpose of interesting capable young people in choosing courses in engineering should emphasize *qualification*. The opportunities for a career in a great constructive profession which is the basis of our high standard of living should be properly evaluated. Although there is a need for more engineers today, nobody knows what the employment potential is going to be four years hence. The profession may do itself a grave disservice by attempting mass recruitment in the face of an unpredictable national economy.

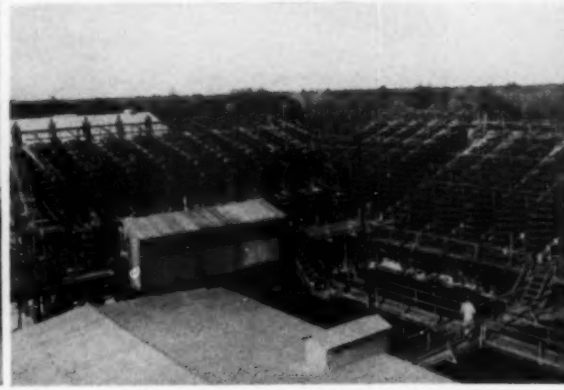
The mining and metals industries are in a special position as fewer engineers are needed in these fields. Only 10 pct of all engineers are mining and metallurgical engineers. Today's shortage is not so much in recent graduates, but in trained practicing engineers. The shortage has served the profession to good effect because it directed the talents of engineers into more productive channels. In some areas high school graduates have been put into routine jobs such as surveying. If there is one thing the mining profession does not want, it is an oversupply of graduates which would relegate college men to years of work and discouragement in routine jobs.

The public has a clear cut picture of the legal and medical professions and thus the respect knowledge imparts. But the engineer is variously thought of as a man who pulls the throttle lever on a locomotive, tends a furnace, or builds a bridge. The term *engineer* is too loosely used. For instance we have heard of "crowd engineers" and "exterminating engineers." In some unions an engineer designation has been established to describe a person doing routine checking or other control job. We do not disparage these positions but they are different from the work done by the man qualified by years of experience and study. Many of these so-called engineers are not engineers at all.

The engineering profession has cooperated closely on a program of recruiting high school graduates for engineering study. It should start a cooperative public relations program to enlighten the public on the accomplishments and work of engineers. This type of publicity need not be of the bombastic type. It can be educational and dignified. Radio, television, and the periodicals can be used to convey information. It is time that laymen and interested young people learn to make a distinction between the true engineer and the technician. Such a program would instruct parents and high school students and thereby interest the right type of people in the engineering profession.

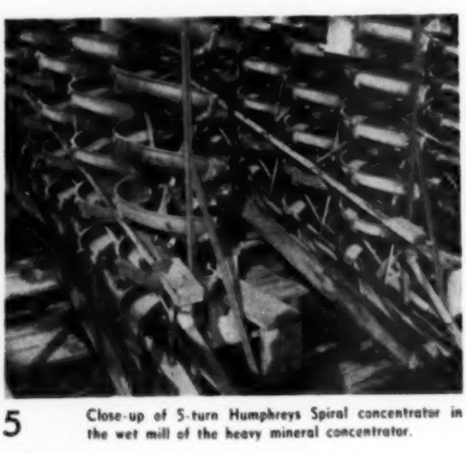
The Centennial of Engineering sponsored by the American Society of Civil Engineers is a step in the direction of instructive public relations. This fine start should not be allowed to remain as a one pass venture. The engineering profession as a whole should follow this exposition with a sustained, well directed effort to inform the public of the engineer's work and the possibilities it holds for a constructive career.

1 Sand is mined by a hydraulic unit of the type used for river dredging. Approximately 400 tons per hr are mined and pumped together with 7000 to 10,000 gallons of water to the concentrator. Shown is a bow view of the dredge.



2 Main spiral plant treating 7500 tons per day of crude ore containing 4 pct heavy material, consisting of 252 five-turn spirals in the rougher unit, 54 five-turn units

4 Slurry from the dredge is cleaned of roots and trash in trommel screen. Feed bins for spirals are in the foreground. Spirals to the left are part of rougher mill.



5 Close-up of 5-turn Humphreys Spiral concentrator in the wet mill of the heavy mineral concentrator.

Jacksonville Plant Titanium

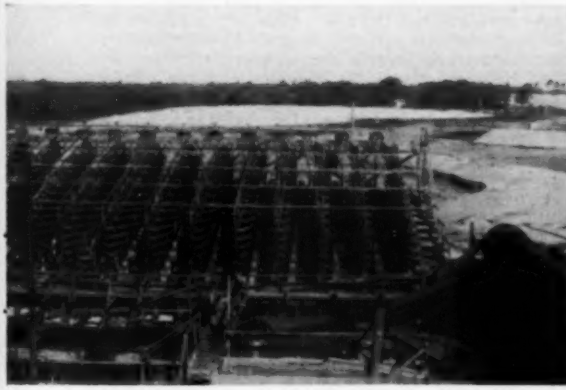
by J. C. Detweiler

THE Jacksonville plant of Humphreys Gold Corp., operating under leases from National Lead Co. and Rutile Mining Co. of Florida, recovers rutile, ilmenite, zircon, and monazite from an ancient beach deposit containing about 2.5 pct of these minerals in combination. The location of the plant is unique, being situated about ten miles from the center of Jacksonville, Fla., surrounded by a thriving suburb. Two four-lane highways pass within 1½ miles of the plant. An expressway now under construction will pass over the tailing pile, within 500 ft of the mine office. The elevation at the plant site is approximately 50 ft above sea level.

This is one of two mines producing titanium minerals and zircon in Florida. Another mine is also operated by Humphreys at Starke, about 50 miles southeast of Jacksonville.

The Jacksonville deposit extends about six miles in a north-south direction, averaging approximately one half mile wide and twenty ft thick. Values begin at the surface over most of its length and ter-

MR. DETWEILER is Technical Superintendent of Humphreys Gold Corp., Starke, Fla. He is an AIME member.



in the cleaner section, and 18 three-turn finishers. The bulk concentrate from the wet plant contains 90 pct heavy mineral.

3 Ilmenite-rutile concentration section, showing wet concentrate stockpile, feed bin and oil fired kiln dryer. Dried concentrate is feed for the electrostatic separators.

Produces From Beach Deposit

minate in a layer of clay at the bottom horizon. To the south it plunges beneath the surface and is covered with about twenty ft of over-burden. About 2½ miles of the northern end are covered by this operation. The sand contains 4 pct heavy minerals, of which 40 pct is ilmenite, 4 pct leucoxene, 7 pct rutile, 11 pct zircon, and less than 0.5 pct monazite. The balance of the heavy minerals group is made up of various silicates, including sillimanite, kyanite, staurolite, tourmaline, and garnet.

The first operation on this deposit was by The Titanium Alloy Manufacturing Co., a division of National Lead Co. and its subsidiary, Rutile Mining Co. of Florida. They erected a dry mill containing electrostatic and electromagnetic equipment for the separation of ilmenite and rutile from bulk concentrate produced in a wet plant. The wet plant was equipped with tables to treat part of the feed, and flotation to treat the balance. Both methods were unsuccessful in producing at a satisfactory rate or recovery. In 1944 Humphreys took over the operation and installed a plant using Humphreys Spiral Concentrators for bulk concentrate production. Output was increased, mining methods improved, and a

6 Ilmenite-rutile section of dry concentrator using modified roll type electrostatic separators to remove the conductive titanium minerals from the silicates.

7 Wetherill type cross belt magnetic separators produce a concentrate containing 95 pct monazite. In the foreground is the bagging equipment for the monazite concentrate.

unit installed for the recovery of zircon during 1944 and 1945. These changes made it possible for the plant to continue in competition with foreign ores after the last war.

The sand is mined by a hydraulic unit of the type used in river dredging. About 400 tons per hr of sand are mined, and pumped with 7000 to 10,000 gpm of water to the concentrator through an 18-in. pipe line. The 16-in. dredge pump has a range of about 4000 ft. A booster pump is added to the line as mining moves to the outer limits of the property which are about 7500 ft from the concentrator.

The concentrating plant has four units. They are:

1. The main spiral plant treating 7500 tons per day of crude ore containing 4 pct heavy mineral, producing a heavy bulk concentrate containing 90 pct heavy mineral.
2. The ilmenite-rutile dry mill treating bulk concentrate in order to separate the titanium minerals from the silicates, and producing separate concentrates of ilmenite and rutile.
3. The zircon spiral plant which reconcentrates the ilmenite-rutile tailing to produce a crude zircon-monazite concentrate.
4. The zircon dry mill in which finished zircon and monazite products are made from the zircon spiral concentrate.

The wet concentrating units have a flow sheet similar to any simple gravity concentrating plant. A rougher stage treats new feed and rejects final tailing. Concentrate is treated on successive stages of cleaners and recleaners. Middling is recirculated in the stage from which it originated and cleaner or recleaner tailing is recirculated in the preceding stage.

Inverted pyramid bins provide storage and thickening capacity for each rougher and cleaner section of the two spiral plants. Feed from each bin is pumped to the spiral section it serves by a unit sized to provide a constant flow of the required pulp to each spiral. The pump suction extends to the bottom of the bin in order to pick up the sand. The amount of sand pumped is regulated by adding controlled amounts of dilution water near the intake of the suction pipes. Pulp from the pump is distributed through a branched piping system to open-top headers at each row of spirals. Dividers at the top of the headers split the feed for gravity flow to each of the spirals. The spirals are arranged in stepped rows on wooden structures along the sides of the bins. Tailing, middling, concentrate, and other products flow by gravity to their respective terminals.

The dry mills use high-tension separators which are modified roll type electrostatic machines. These machines make a separation between the conductive titanium minerals and the silicates, including zircon and monazite, which are non-conductors. Each machine consists of a feed bin, a rotating roll, and splitter boxes underneath the roll directing the products into separate channels. As feed is distributed in a thin layer on the roll, silicates are pinned to the roll by a high voltage current, and are brushed off into the tailing box. Titanium minerals which are not pinned are thrown into the concentrate box by the rotation of the roll. All of the rolls are operated in parallel, each receiving a proportionate amount of the same feed. Products are conducted vertically by elevators and horizontally by gravity, screw conveyors, or conveyor belts. Electromagnets complete the separation of the various products.

The material flow through the plant begins with the main rougher spirals. After screening on a trommel for trash removal, the pulp from the dredge is received in a rougher feed bin and is treated on 252 five-turn spirals. This section produces a final tailing later pumped to back-fill previously mined areas. Rougher concentrate is treated on 54 five-turn spirals in the cleaner circuit and the resulting concentrate recleaned on 18 three-turn spirals to produce finished concentrate. The recleaner concentrate is de-watered in a screw classifier and transported to a stock pile by a stacker belt.

Concentrate from the stock pile is dried in an oil fired dryer and fed to the rougher section of the ilmenite-rutile mill containing 19 high-tension separator units. The rougher tailing is retreated on seven scavenger units and the concentrate cleaned on nine units. Three induced roll electromagnets extract ilmenite, assaying 60 pct TiO_2 as a magnetic fraction, from the cleaned concentrate. The non-magnetic fraction contains rutile and non-magnetic silicates. Cleaning of this product on three cleaner and one recleaner high tension units produces rutile, assaying 92 pct TiO_2. Both products are elevated to storage bins.

Final tailing from the ilmenite-rutile mill is pumped to the rougher bin of the zircon spiral plant. Twenty-four five-turn Humphreys spirals in this section produce a final waste tailing, and a concentrate which is given a preliminary cleaning on 12 three-turn spirals. Concentrate from the second group flows to the cleaner bin and is cleaned in 12 five-turn spirals and recleaned in 12 three-turn spirals. The recleaner concentrate contains about 85 pct zircon, 2 to 3 pct monazite, and is virtually free from quartz and non-magnetic aluminum silicate minerals. A screw classifier de-waters the concentrate which is discharged directly to an oil fired dryer. The dried concentrate is stored in covered bins used to feed the zircon dry mill.

In the zircon dry mill the spiral concentrate is treated on two groups of four high tension separators for removal of remaining titanium minerals. The mill is operated on a semi-batch basis with no circulating load. Generally, the concentrate is given four passes over the high tension separators. Tailing from each pass is returned to the ilmenite-rutile mill for additional recovery of those minerals. The final concentrate from the high tension section is given two successive passes over an induced-roll magnet. The non-magnetic fraction from this operation is a finished product containing about 98 pct zircon, less than 0.25 pct TiO_2, and less than 1 pct of either quartz or Al_2O_3.

The magnetic fraction contains about 15 pct monazite, 40 pct zircon, and various magnetic silicates. This product is accumulated, and on days when the ilmenite-rutile mill is closed it is run through the entire zircon circuit. Most of the silicates are eliminated by the spirals and additional zircon is recovered in the dry mill. The monazite content of the magnetics resulting from this run is increased to 60 or 70 pct. This concentrate is further treated on a 7-pole wetherill type cross belt magnet which rejects the remaining silicates from 4 poles, and produces a 95 pct monazite product from the other three. The non-magnetic fraction is mainly zircon which is returned to the mill feed.

Monazite is packed in 100-lb bags for shipment. Ilmenite, rutile, and zircon are trucked about eight miles to a railroad, and bulk loaded in box cars.

Impact Crushing For Reduction of Hard-Abrasive Ores

by W. W. West

MACHINERY used for size reduction of materials may be divided into three classes—depending upon the manner in which the crushing force is applied. In the first class could be listed the primary crushing units, such as the jaw crusher and gyratory crusher—which crush to coarse sizes by applying pressure intermittently between converging surfaces. In the second class may be listed crushing units, such as the hammer mill, roller mill, and ball mill, which crush principally by grinding or attrition. In the third class is the impact mill which, as the name infers, crushes by impact.

The second and third classes generally include machinery used as secondary units for intermediate or fine crushing and grinding.

Theory of Crushing by Impact

Throw a stone into the air and give it a severe blow while it is momentarily suspended, and it shatters into several pieces. The impact crusher uses this "batting" principle, but carries it one step further. As the material to be reduced enters the crushing chamber, it receives a severe free-air impact blow by hard-hitting beaters suspended from rotor discs. The shattered particles formed are then driven at high velocity against impact blocks, where a further reduction in particle size takes place. The rebounding particles from the impact blocks are again caught by the beaters, and the process repeated until the material is swept out of the open bottom of the crusher.

MR. WEST is Chief Sales Engineer of Pennsylvania Crusher Co., Philadelphia.

Impact Crushing Versus Attrition Crushing

Fig. 1 shows a Hammermill type of attrition crusher. This particular mill has central feed and is reversible. Because of the central feed, an impact section can be designed into it at the feed entrance for preliminary crushing, followed by the cage bar attrition area for final sizing. The material is caught and held in a crushing chamber enclosed by grate bars or perforated plate. It remains in this chamber until it is reduced to particle size small enough to pass through the openings between the bars or in the plate. In this manner the top particle size discharged from the mill is closely controlled. As the swinging hammers pass through the bed of material, the material is broken down by a scrubbing action between hammers and material, material and grate bars, and material against material. This attrition produces a rounded particle shape, accompanied by slivers and a comparatively high percentage of fines. The crusher is especially useful in industries where the material treated is not too abrasive, such as limestone, cement or coal plants. It can be readily understood that from the maintenance standpoint, it is not suitable for hard abrasive materials such as refractories and aluminum oxides.

One common type of impactor is shown in Fig. 2. The bottom of this type crusher is entirely open and the passage of the material through the crushing chamber is almost instantaneous. Liberal clearances are maintained between the impact hammers and the anvil type breaker blocks. This eliminates practically all attrition. It is the elimination of attrition that makes the impactor particularly adaptable for reducing hard, abrasive materials. The impactor is also well suited for the reduction of wet or frozen materials, which clog an ordinary Hammermill. Particles broken by impact, when examined under the microscope, show a distinct tendency toward rough, cubical shape, with a minimum of fines. Another important factor in impact crushing is that crushing is accomplished along natural cleavage lines, thus freeing foreign ores or materials.

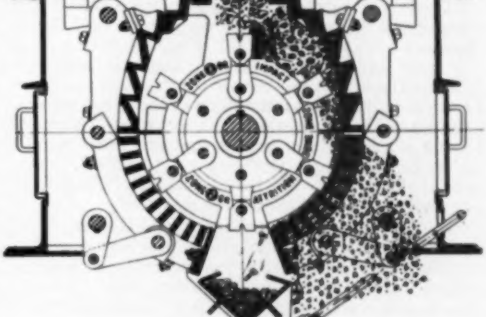


Fig. 1—Hammermill type of attrition crusher, which crushes both by impact and attrition. Because of the attrition feature, hard abrasive material cannot be crushed without high repair costs.

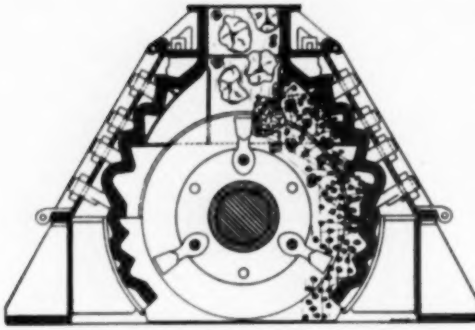


Fig. 2—Impact crusher utilizing the striking force of hammers to break material, with free fall from crusher. Attrition or rubbing does not occur in the mill. Product from this type of machine is cubical in shape, and contains a minimum of fines

Operation of an Impactor

An impact mill is usually operated in a closed-circuited grinding system. In closed-circuit grinding the partially finished mill discharge is carried to external screens or classifiers for separation. The finished product is separated and carried to the storage bin or to further processing, while the oversized particles or tailings are returned to the impactor for further grinding.

Closed-circuit crushing has many distinct advantages over open-circuit crushing. In open-circuit crushing the material must be held in the crushing chamber until reduced to the desired top particle size by a single passage through the mill. This results in overgrinding of a large percentage of the product, with a corresponding increase in power consumption and wear on the mill. In closed-circuit crushing the sizing of the ground material is centered in the classifier or on the screen, leaving the mill responsible only for crushing the oversize material and allowing it to be fed at a rate, and with a load permitting operation at maximum efficiency.

The question may be asked, how much circulating load can be handled in an impact mill? To answer this question, three factors must be considered: First, the particle size desired in the product, both top and bottom sizes; second, the tonnage of finished product desired; and third, the maximum capacity of the crusher. For example, 10 tons per hr of finished product are desired, 100 pct of which must pass a 10 mesh sieve with a maximum of 10 pct passing a 100 mesh sieve. A test run by the impactor shows an analysis of 50 pct passing 10 mesh and 5 pct passing 100 mesh in one pass through the mill. Therefore a 100 pct circulating load is required and the mill must be capable of handling a total feed of 20 tons per hr, 10 tons per hr of which will be tailings, and 10 tons per hr of which will be new feed.

In general if the size of feed and kind of material remain constant, the control of the sizing of the product discharged from the impactor is accomplished by speed regulation of the rotor. The impactor rotor may be considered as a large flywheel and, therefore, the impact energy varies directly as the square of the velocity.

To obtain the maximum reduction at a given speed of the impact rotor, the material should be fed at a height allowing it to enter the crushing chamber deep enough to absorb the full impact blow of the rotating beaters. If it does not enter the impactor deeply enough, it is struck by only the top edge of the beaters with a resulting "foul ball" effect. If the material enters the impactor at too high a speed it passes through before it can be struck squarely by the beaters.

In Fig. 2 it can be seen that in this type mill the material enters in the top of the center of the machine. The selection of the best vertical height for feeding the material may be obtained from the formula $S = \frac{360V}{RPM x N}$, where S = average entrance in inches of material on beaters, V = velocity of material in feet per second, RPM = revolutions per minute of the rotor, and N = number of beaters around the circle.

Impact Beaters, Feed Drop, and Capacity

The number of beaters across the width of the rotor is regulated only by the size of the unit required to produce the desired capacity. It has no relation to the product received or the height of drop required for the feed.

The number of beaters around the rotor circle does not have an appreciable effect on the product sizing, but it has an important relation to the headroom needed for proper installation and, to a limited extent, the capacity that can be produced.

Referring to the formula $S = \frac{360 V}{N x RPM}$, it can readily be seen that as N, the number of beaters around the rotor circle is increased, either the velocity of the incoming material must be increased, or the rpm of the rotor must be decreased if S, the depth of penetration of the feed, is to remain constant. Since it is necessary to keep both the penetration of the feed, and the rpm of the rotor constant for the best product sizing, the only variable that can be changed is V, the velocity of the incoming feed. We know that to raise this velocity will require a higher free vertical drop from the entrance point into the feed chute to the beater circle of the crusher. Since the feed is then flowing into the mill at a faster rate, and there are more beaters per minute to crush it and sweep it through, there is a corresponding increase in the mill capacity. However, this increase can only attain the maximum capacity for which the mill is designed. It must also be remembered that the number of hammers around the rotor circle must not become so great that the height of feed drop becomes impracticable, and proper feed penetration cannot be obtained.

Conclusion

The Impactor is comparatively new to industry. Unfortunately, previous attempts at crushing by impact met with unsatisfactory results, and even failure of the machine itself.

The impact crusher is not meant to be a cure-all for all difficult reduction problems. It has been installed on difficult crushing jobs, such as the abrasive aluminum oxides, feldspar, and perlite, with success, and is rapidly finding new fields.

It has been proved of merit where a more cubical particle shape is desired, or a minimum of fines are required. There are many materials for which it will not give suitable reduction, or for which another type reduction would be more suitable.

New Chemical Method Recovers

Nickel Cobalt Copper | Metal

DEVELOPMENT of a chemical process for the extraction of pure metals from mill concentrates or metal scrap has progressed beyond the pilot plant stage and may prove an important adjunct to present smelting and refining methods if initial commercial operations prove economically successful.

Developed by the Chemical Construction Corp., the new process involves the treatment of oxide and sulphide ore concentrates by chemical methods, instead of the usual smelting and refining techniques. Several of the many applications are now scheduled for commercial use. Refiners using the new process will prepare ore concentrates by standard flotation methods, introduce the concentrate as a slurry into an autoclave along with water and an acid or ammonia. From the resulting leach solution, recovery of individual metals is made by use of suitable reducing agents. By varying conditions during treatment, different metals in the ore are produced separately as pure powders, which may be pressed into forms ready to market, or in the case of copper, extruded as rods or pipe. The reagents are generally recovered. By manipulating the variables during reduction, selective separation of nickel, and/or cobalt, and/or copper can be made simultaneously. The separation is a continuous operation.

Low metal prices are not immediately in view because of the tremendous demand at this time. However, reduced metallurgical treatment costs will allow economical mining of orebodies with lower metal content, permitting increased production to meet demand. Although the practical horizon for use of the new process appears to be limitless, one factor may enter into its employment. Just how low grade a concentrate can be economically used is unknown. In addition, for present practical considerations, only metal below zinc in the electromotive series may be processed.

Each commercial application requires specific technique adaptation and pilot-plant data for engineering design. A nickel-cobalt-copper process has been researched and piloted in collaboration with Sherritt Gordon Mines, Ltd., for the firm's Lynn Lake properties. In addition, processes were tailored for cobalt concentrates of Howe Sound Mining Co., and National Lead Co., in view of the urgent need for this specific metal.

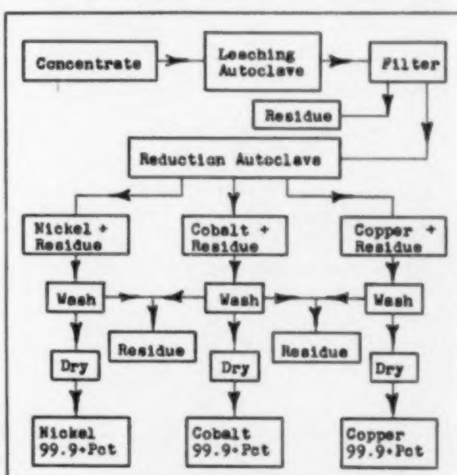
Major General William N. Porter, president of Chemical Construction, says of the new process, "piloting experience has shown that production cost, from ore concentrates to pure metals should be considerably below current costs." Other savings may be realized by cutting transportation and personnel costs, and by reducing the time lag between mining and pure metal from months to a matter of hours.

First commercial use of the process will start sometime this summer. Chemico is slated to finish building a $2.5 million cobalt refinery for Howe Sound Mining near Salt Lake City. The plant is expected to raise world cobalt production by 40 pct. The plant will process 35 tons of 20 pct cobalt concentrates from Howe Sound's Blackbird mine near Cobalt, Idaho, daily. Yearly production is expected to reach 2000 tons of pure metal, about one half of U. S. consumption in 1950.

Steps in the Howe Sound application of the process are:

1. Acid oxidation leach.
2. Filtration (residues thrown away are insoluble compounds—gangue, iron, arsenic).
3. Cementation (for Cu removal because Cu content is too low for recovery).
4. Reduction from ammoniacal solution.
5. Separation of Co and Ni as mixed metals (95 pct Co and 5 pct Ni).
6. Recovery of ammonium sulphate.

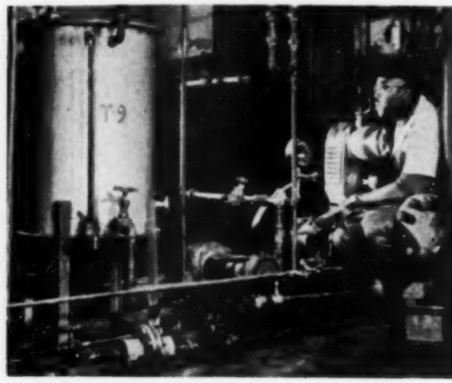
Under construction at the Fredericktown, Mo., mine of National Lead is a $5 million refinery sched-



Hypothetical flow sheet for the simultaneous recovery of nickel, cobalt, and copper. Basic operations are performed in autoclaves, under controlled pressure and temperature.

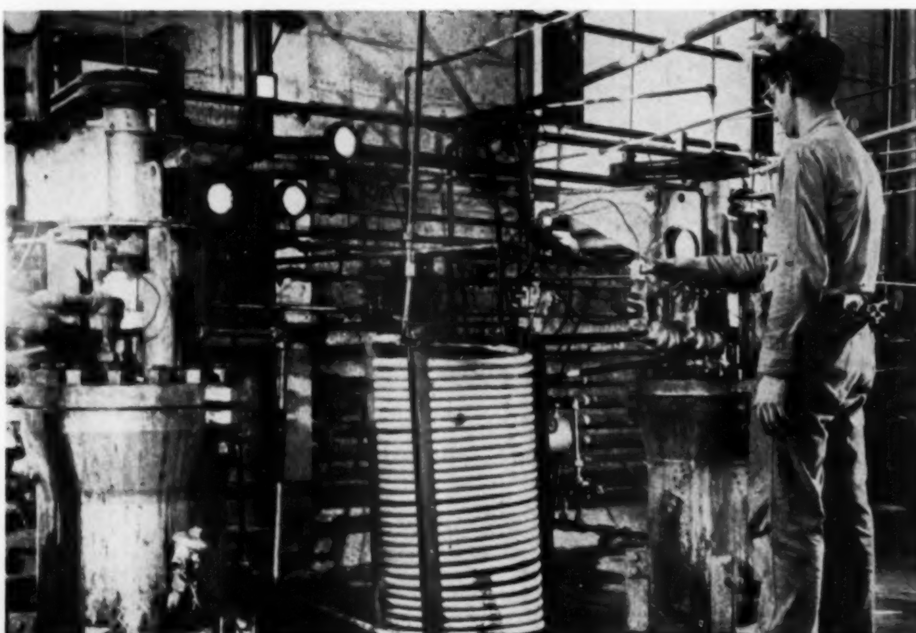
uled for completion in 1953. It will have a designed capacity of 50 tons of concentrate per day. National Lead plans an annual production of 700 tons of cobalt, 900 tons of nickel, and 700 tons of copper, in addition to 7500 tons of fertilizer-grade ammonium sulphate.

Recovery of copper from copper scrap is shown at Chemico's pilot plant in Linden, N. J.



Step 1 (Left)—Basket of scrap is lowered into the leaching solution at the beginning of the process. This, and other steps will be fully mechanized in commercial plant operation. Leaching is done in autoclaves.

Step 2 (Above)—Solids are filtered out of the solution. The solution is then pumped to the measuring tanks feeding the reduction autoclaves.



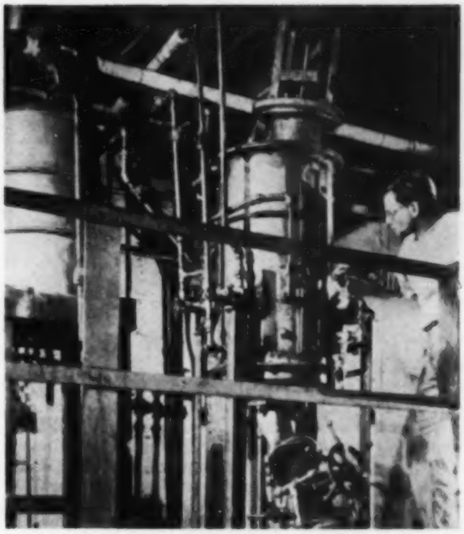
Step 3—The autoclaves (flanking the coils) are the heart of the process. In the autoclaves, the copper is precipitated from solution under high temperatures and pressure with reducing agents. Two coils, one inside the other (center), are for heat exchange—heat from precipitated copper leaving the autoclaves is transferred to solution going into them.

Another development is the $17 million nickel refinery under construction for Sherritt Gordon at Edmonton, Alberta. Sherritt Gordon's ammonia leach process and Chemico's nickel reduction process are to be combined. Annual production is anticipated at about 8500 tons of nickel, 1000 tons of copper, 150 tons of cobalt, and 70,000 tons of ammonium sulphate. The Edmonton plant is scheduled for production in the fall of 1953.

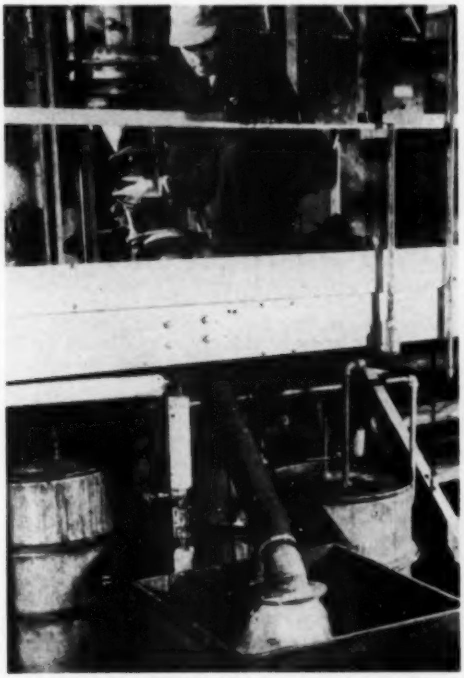
One of the most significant developments from the new process which may soon find commercial application is a method for production of pure copper powder from any form of copper scrap, brass scrap, or blister copper. The process is said to achieve almost 100 pct recovery. The product, better than 99.9 pct pure, meets all standards for oxygen free, high conductivity electrolytic copper. The process was developed in collaboration with Chemetals Corp.

In September 1951, Chemetals began collaboration on a technique to produce sintered manganese oxide from low grade manganese ores. Chemetals and Chemical Construction will start joint pilot operations in the near future. A moderate amount of material is needed to make the changeover from smelting and refining methods to the new process, according to General Porter. Efficient and compact plants may be built at the mine site with accompanying cuts in transportation costs. Other advantages pointed out for the process are the overcoming of inventories of partially processed material piled up because of distance between smelters and refiners. Present time lag in production may extend over a period of months.

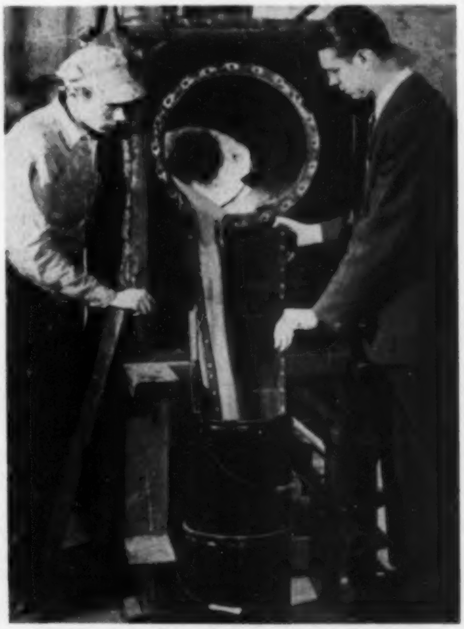
Rights to many of the processes are shared by Chemical Construction and Sherritt Gordon, the latter building and operating a pilot plant at Ottawa. Rights to the copper scrap and manganese processes are shared by Chemical Construction and Chemetals.



Step 4—Washing tanks receive the copper after it is precipitated in autoclaves and wash away leaching solution.



Step 5—Water and powdered copper pour out of washing tank into box filter for preliminary drying.



Step 6—Gleaming copper powder pours from rotary drier in the process's last step. George Van Hare, right, of Chemical Construction inspects the powder. Equipment for continuous drying will be installed in commercial plants.

Geological Engineering — A Curricular Outcast?

by P. J. Shenon

ENROLLMENT in geological and mining engineering curricula is declining at an accelerated rate despite the greatest need for trained men ever extant in the minerals industry. Industrial and military demand is mounting, but the number of freshmen selecting the mineral field continues to fall. Estimates on the needs of industry range as high as 30,000 new engineers a year. The current deficit is more than 60,000 engineers less than the 350,000 to 450,000 which eventually will be needed.

The indisputable fact is that the colleges are turning out fewer and fewer engineers despite the greatest enrollment in colleges and universities ever experienced in the United States. In 1950 a record 52,000 young men stepped out of the confines of ivy covered walls with engineering degrees in their hands. By 1951, however, the number dropped to 41,000 and present enrollment indicates a national graduating class of only 25,000 for 1952. No letup in the drop is forecast. About 19,000 can be looked for in 1953 and 1954 may reach an unhappy 12,000. It becomes clear that something must be done to attract high school graduates to engineering.

One immediate possibility could be to make the course burden carried by the engineering student somewhat lighter. The prescribed curriculum in many schools is such that the student takes the path of least resistance, and instead of training for an engineering future, studies for a vocation which will allow him to learn and at the same time get at least a nominal enjoyment out of college life.

Review geological and mining curricula of 20 colleges and it will be found that the engineering student is a veritable pack mule compared to a lad taking liberal arts or some other non-technical program of study.

The curriculum for geological engineering at one school calls for 202 semester hr, with almost 23 hr carried per semester. Multiply this figure by three hr, the minimum supposedly to be devoted to a credit and you get 69 hr per week. With a bare minimum of 84 hr for sleeping and eating, about two hours a day remain for recreation. However, the load of other schools investigated is about 19 hr.

The University of Utah requires 238 quarter hr for graduation with a degree in geological engineering, while requiring only 183 quarter hr for baccalaureate degree from University college, Utah's liberal arts school. It can be stated with a measure of surety that the same proportions exist in other universities. The first step would be for ECPD to review its requirements for mining and geological engineering. It must recognize that mining and geological engineers operate in a specialized field, as do other types of engineers. Although a geological engineer may not design a bridge, as pictured by the ECPD Committee on Engineering Schools, his field of design calls for similar engineering precision, a knowledge of materials, construction methods, economic considerations, and financing.

DR. SHENON is Professor of College of Mines & Metallurgy, University of Utah, Salt Lake City.

Six schools have been accredited by the ECPD. What is the basis for approval and can the requirements be modified and still be kept in line with the needs of the geological engineer? Course work from school to school varies with the exception of mathematics, chemistry, and physics. Even in those courses the not inconsiderable variation lends dubious creditability to the mean. One accredited school requires 7 1/3 semester hr of chemistry, compared with 24 hr required by another, making an average for the six schools of 17 1/3 hr. Required credit hr in mechanics ranges from 4 to 18 and in surveying from 2 to 15. Several non-accredited schools require more hr than do the accredited schools in some courses.

Why is the engineering student forced to carry such a back-breaking load? The answer is of course fairly obvious. He is irrevocably set apart from the rest of the student body because of the nature of his life's work. He is training for a place in a world where technology is becoming increasingly involved. He must be prepared to do a job now—and not later. Mining and geological engineering require the same essential backgrounds as other engineers, and more. The "more" is a knowledge of mining methods, metallurgy and geology for the mining engineer. The geological engineer must know in addition, mineralogy, petrography, and geophysics. The load is compounded finally by the addition of liberal arts courses. Should anything be done to relieve the situation?

Today's engineer must be a whole man, capable of handling the tools of communication and with an understanding of the economics of industry. He must be able to write clear simple English, and he must be man who can think from some other position than bent over a work table. He must be aware of the history of his country and to some extent that of the world. Not all schools share this view. Only two of the accredited schools require history courses. However, five of the non-accredited schools make it mandatory. Four accredited and five of the non-accredited schools require economics.

Courses in mathematics, physics, and chemistry are fundamental in engineer training. The average for the accredited schools could serve as a guide in

assigning hour values here. Nor would most schools object to average course requirements for geology, mineralogy, petrology and petrography. They are basic for the geological engineer, as is a knowledge of geophysics. It may be that the student can devote his time with greater benefit to some other courses more closely related to the problems of his field, rather than to hydraulics or mechanics.

Choice of a particular area in the mining scope is often dictated by geographical surroundings. Thus, the major engineering branch may vary with the section of the country. Six credit hours is a fair average for the required credit hours of major engineering subjects in the schools considered. Surveying, however, is somewhat different. A solid mapping job cannot be done without a good foundation, but how much should be required of the student is debatable. Perhaps the answer lies midway between the requirements of the accredited and non-accredited schools.

Electives are desirable, but under present conditions, the time just may not be available. More hours are needed for physical and military training than ever before. Another course which could benefit the geological engineer is one in geological map designing, in which mine layouts are stressed.

Some believe standardization is unwise and even dangerous, but a set of rules is needed by accreditation groups. Mining and geological engineers on the accreditation groups should be the ones who are chiefly responsible for drawing the standards.

Acknowledgments

The writer wishes to acknowledge the comments and suggestions of C. J. Christensen of the University of Utah, M. I. Signer of the Colorado School of Mines, E. M. Thomas of Texas Western College of the University of Texas and E. H. Wisser of the University of California, Div. of Mineral Technology.

Discussion of P. J. Shenon's Geological Engineering — A Curricular Outcast?

by O. R. Grawe

PRIOR to the present "Korean police action" we had arrived in June 1950 at a point of supersaturation of industry with engineers . . . It has been pointed out that if the future demand for engineers continues to rise at the predicted rate, the situation may still not be as bad as it may seem if we improve the quality of the embryo engineers being graduated from our engineering schools. Professor Shenon suggests that enrollment might be increased by easing up on the terrific course loads . . . Curricula cannot be compared on the basis of credit hours alone, however, because a curriculum of low credit load often comes closer to requiring the three hours of work for each credit than does one of high credit load. A student taking 15 hr may be required to write more reports, spend more time in the library, and takes stiffer quizzes than one who is taking 22 or 23 credit hr. There is a way to reduce the course loads of engineering curricula without seriously lowering academic standards. We now give 9 credit hr in freshman chemistry for the same type of course which used to carry 6 credits. We give 12 credit hr in physics for a course which used to carry six, and 18 hr in mathematics for a series of courses algebra through integral calculus which used to carry about 15. If we reverted to the old standard we would immediately reduce the present curriculum by 12 credit hr and without sacrificing a thing in fundamentals or principles.

We now offer 12 hr in a language students have been speaking from the cradle. Little evidence is found that it has improved the student's English. A good course in business English, correspondence and report writing taught by instructors with first hand experience would do more good than the two years of English as it is now presented.

Professor Shenon and many others are proponents of the term *Geological Engineer*. In spite of the modifications of the definition of an engineer, he is a person who builds something, who constructs something of direct use to man, and is not the mere erector of laboratory equipment or the inventor of a laboratory gadget. Sufficiently broadened the term engineer could conceivably include anyone. When the geologist and geophysicist starts supervising the construction of a building, the driving of a drift, or the erection of a derrick, he ceases being a geologist or a geophysicist and commences to be a civil, petroleum or mining engineer. But he won't become a geological or geophysical engineer by taking a hybrid four-year course.

As pointed out by Professor Shenon, an attempt has been made to improve engineering curricula by the miracle of accreditation. What is involved in accreditation? (1) The courses included in the formal prescribed course-of-study. (2) The physical and financial ability of an institution to live up to its obligations as measured by such material factors as: Number of staff members, degrees they hold, size of library, amount of research conducted, and administrative attitude toward education and availability of funds.

The most significant thing about accreditation is that it does not involve the ability of the teaching staff to teach. If we do not, or admit that we cannot evaluate this factor, we might just as well forget the others. Similarly the quality of student graduated is not considered, nor is their success or lack of success considered.

Curricula which fail to take into account individual differences and preferences of students fail to offer the best education for the student. Too much regimentation is bad, even in education. I doubt that any educator or group of educators can design a curriculum which will adequately meet the demands of every student. With accreditation the individual is likely to be forgotten in favor of the profession in general.

MR. GRAWE is Chairman, Dept. of Geology, School of Mines & Metallurgy, University of Missouri, Rolla, Mo.

Open-Pit Forum

Ray Finds That Bottom Dump

by H. Furman Byars

INTRODUCTION of bottom dump hauling units into the Ray, Ariz., stripping operation of the Isbell Construction Co., was motivated by several reasons, with what appears to be debatable results. The accepted theory of truck design for use in open-pit holds that end dump vehicles are the most adaptable for the work. But, because operations of the bottom dump, under certain construction and haulage conditions, proved economically feasible, the unit was put to work in the Ray copper pit. The decision to try bottom dump was reached after considerable observation of the unit in action on construction of earth filled dams, levees, airport construction and several other similar tasks. Basic tire design also motivated the choice.

All things being equal, a vehicle running on low pressure single tires will outperform another operating on dual high pressure tires, providing load carrying capacities are the same. The investment required to equip a vehicle with four single tires to handle the same load as one with dual tires mounted on two axles and single front axles is about 60 pct greater. Thus, in order to reach the break even point on tire costs, single tires must operate 60 pct longer. Comparison is made with a truck outfitted with 10 16:00x25 tires.

Two other factors were considered in selecting bottom dump trucks. It was felt the bottom dump principle would work well in dumping ore into a hopper where gate design fits this particular method. Also, with the absence of hydraulic dumping, ore pollution with oil is reduced.

MR. BYARS is Superintendent of Isbell Construction Co., Ray, Ariz.

The mechanical simplicity of the unit also lent weight to its choice. Ordinary reasoning indicated maintenance costs would be low compared with other units carrying similar loads.

The bottom dumping principle is not new. It dates back to the days when horses were used to haul the same kind of rig. The unit employed at Ray holds 25 cu yd struck measure, or approximately 42 short tons.

Dumping is accomplished by releasing an air cylinder opening a dog holding the doors. Doors are closed by a cable system operating off a wheel wind deriving power by friction with the trailer tire. The unit is mounted on four 27.00x33 and two 14.00x24 tires on the front axle. The power unit is a 300 hp Cummins engine. Hydraulic power boosts the steering. A straight mechanical drive and friction clutch with 10 speeds is used.

Conditions Not Ideal

Top performance of the truck can be expected only under the conditions for which it was designed, in particular grades under 5 pct, handling fine material, and dumping where one thin layer can be placed on top of another.

The machine will handle 42 tons per haul, operating at high speed, with only seconds used for dumping. On a 2 or 3 pct grade over a one mile haul,

Shovels load the 42-ton bottom-dump units. The six pct grades encountered in leaving the open pit (road in foreground) limit the desirability of bottom-dump trucks. General view of the Ray copper pit in Arizona.

Haulage Units Lack Flexibility

the truck will handle almost 275 tons per hr with a minimum of maintenance.

At Ray, the trucks were used on 6 pct grades because of the physical nature of the pit. With the added drawback of not being loaded with the type of material the truck was designed for, operational conditions were hardly ideal. Considerable absence of traction is encountered on a 6 pct grade by the bottom dump. With muddy road conditions, the slippage is even greater under the drive wheels, causing accelerated tire wear.

Tire abuse also takes place when dumping. The trailer straddles the immediate unloading area, of course, and in order to clear oversized rock a wind row is dumped over a fairly wide area. A portion of it extends under the trailer, causing chipping and cutting of side walls and treads.

Use of the bottom dump for ore haulage proved to be under expectations. Ore is dumped over a grizzly, where large matter is grizzlied off for the primary crusher, while fines pass through spacing for direct feed to the conveyor belt. Because unloading speed from the bottom dump cannot be controlled, the entire cargo hit the grizzly en masse. The angle of the grizzly bars threw the material on the feeder and piled it up to the point of plugging the crusher.

Engine repair has been high, perhaps for psychological reasons. The truck is definitely slower than other vehicles operating on the same grade and it may be drivers have been demanding more than the engine is capable of delivering, in an effort to keep up. The condition persisted despite definite rules to the contrary. Transmission life also has been short, but for more usual reasons.

The truck is inherent to all the ills of manually operated transmissions. Shock loading by improper clutching and poor gear selection have also shortened running life.

Tests Not Conclusive

The units have operated at 84 pct availability, averaging 110 tons per hr on hauls of 1 2/5 miles. Total difference in elevation from mining cut to dump is 240 ft.

The use of bottom dump trucks is a case of taking a specialized vehicle and placing it under conditions where best performance might be had with a truck designed to do a universal job. Yet, the operation at Ray is by no means conclusive evidence of the impractibility of using bottom dump trucks for open-pit mining. They were used on grades which were too steep, loaded with material the hoppers were not designed to handle, and engines were strained beyond what can be considered normal. With all that, costs were so close to those experienced in operating equipment hauling similar loads, that Ray is loathe to entirely remove the bottom dump trucks from the pit. Indications are that the truck can be operated to great advantage under certain conditions. The best bet must be predetermined by careful consideration of the truck's strong factors, its weaknesses, and the pit in which it is to be used.

Large 25-cu yd haulage trucks are very serviceable units when operated under conditions that do not call for handling large-size material and steep grades. Reduced weight on driving wheels of the tractor of this type of unit increases tire wear because of slippage.

Centrifugal Machine For Cleaning Coal Washery Water

by K. Prins

ONE of the more pressing problems faced by the coal industry today is the development of adequate means for meeting conservation laws, particularly those involving stream pollution, in various parts of the country. Discharge of dirty coal washery water into streams and rivers is almost universally frowned upon. Many states have enacted laws carrying heavy fines to curb the practice. The Prins streamcleaner is one of the latest machines to enter the market. It is closely related to the cyclone thickener in principle. Eleven streamcleaners are currently operating, ranging in size from 4 to 16 in. diam.

In more recent installations the water enters directly in line and on a tangent with the impeller. The impeller consists of a vertical shaft up through a packing gland and bearings, and a V-belt pulley. The lower part is a tubing fastened to the shaft above, extending through the water intake compartment and provided with six vertical flat bars welded to the tubing. Portholes are situated in the upper end of the tubing, immediately below the point where shaft and tubing join together. The portholes are placed so that they are in open communication with the upper compartment of the streamcleaner from which the processed water is discharged. The impeller is motor driven with a wide range vari-pitch drive employed between motor and impeller. The motor is mounted vertically, and the mounting provided with a vertical hinge allowing for needed adjustment of the wide range vari-pitch drive.

The dirty coal washery water entering the machine under 20 lb psi pressure, flows from the compartment above the impeller, between the impeller blades, and is whirled around in the vertical section of the impeller enclosure. The speed of the impeller supplies centrifugal force and velocity required for separating suspended solids from water. The lower part of the machine consists of a cone, whose action is similar to other machines of the same type. The underflow discharge orifice is a cold rolled steel block machined to correspond with the cone angle and allows insertion of steel tubes of different diam.

On 16 in. machines a 1¾ in. ID vertical discharge pipe is used. Provision is made for attaching a curved section of the same diam to the vertical pipe, to which, in turn, different lengths of horizontal pipe can be connected.

Curved Pipe Advantageous

It has been found that a curved pipe offers resistance to discharged material flow. In addition, the rotary motion of the underflow can be easily arrested in a curved pipe.

MR. PRINS is with K. Prins & Associates, Williston, Ohio.

Impeller speed of the 16 in. diam machine is provided from 400 to 800 rpm. A speed of about 474 rpm is suitable for maintenance of a constant underflow in coal slurry.

In one installation 5x¼ in. coal is cleaned in a Jeffrey Baum type washer at a 225 tons per hr rate. Washer installation is of the conventional type and a drag type sludge tank is used for water clarification purposes. Capacity of the water system, including the Baum washer, is about 40,000 gal. Before placing the streamcleaner in operation, it was necessary to flush out the entire system every five days of two shift operations. The only time the system is drained now is for repair work on the sludge conveyor or the rig.

The suction line of the streamcleaner pump terminates in a number of small branch lines located at a depth of about 4 ft above the sludge conveyor. Each branch line extends the full width of the tank and is provided with four intake ports, each one with a funnel shaped inlet projecting downward. The arrangement provides an extensive pick-up area for dirty water, and the inlets are arranged for a low rim velocity, preventing the taking in of coarse particles.

The funnels are also arranged to extend up or down in the tank. They are set to pick up −60 mesh material exclusively. The material is a high ash and high sulphur product and thus has to be disposed in the refuse conveyor. The underflow of the streamcleaner is discharged on top of the washery refuse which is carried in a drag type horizontal conveyor, discharging into another refuse conveyor inclined at 30° with a short horizontal loading section.

Some Disadvantages

The impeller inherits certain disadvantages because of the nature of its construction. Additional moving parts make it subject to wear and maintenance costs. The advantage of being able to maintain a constant speed, however, to produce desired water velocity in the machine outweighs the drawbacks. Better separation between water and solids can be obtained by regulating time of residence of water through adjustment of valves in the intake and discharge lines.

The amount of fines encountered during plant operation will vary because of higher or lower moisture in coal passing over fine coal vibrating screens. Even the amount of fines picked up by underground loading machines will be inconstant. Consequently, the percentage of solids will vary in water to be processed. The velocity in the feedlines to the slurry thickeners will fluctuate, with the required water velocity lacking. Another advantage advanced for the machine is its ability to operate on 15 to 25 lb line pressures at the water intake, reducing pump power required and pump maintenance.

Mining Operations at The Teniente Mine of The Braden Copper Company, Rancagua, Chile

by F. E. Turton

THE town of Rancagua, at the junction of the state and Braden Copper Co. railroads, is located 82 km south of Santiago, the capital of Chile. From Rancagua 70 km to the east, situated in the Andes at an elevation of 7000 ft, is the town of Sewell, the location of a millsite. Two and one half km east of Sewell by underground railroad at an elevation of 7500 to 10,000 ft is the Teniente orebody.

The history of *El Teniente* dates from the eighteenth century, when according to legend a Spanish lieutenant, or *teniente*, a fugitive from justice, escaped to the Andes and camped at what afterwards became known as the *Mineral El Teniente*. This man reputedly discovered a vein of high grade copper ore. The first official records date from 1819, when some exploitation was begun, and continue until 1870. The orebody was large and of relatively low grade and was beyond the capabilities of the small groups attempting to operate it. No effort was made to erect a concentrator until William Braden became interested in the property.

In 1901 Mr. Braden promoted the necessary capital for the first practical exploitation of the orebody. Barton Sewell and E. W. Nash, both of the

F. E. TURTON, Member AIME, is Vice President of the Braden Copper Co., a subsidiary of the Kennecott Copper Corp.

Discussion on this paper, TP 3314A, may be sent (2 copies) to AIME before July 31, 1952. Manuscript, Aug. 28, 1951. Mexico City Meeting, October 1951.

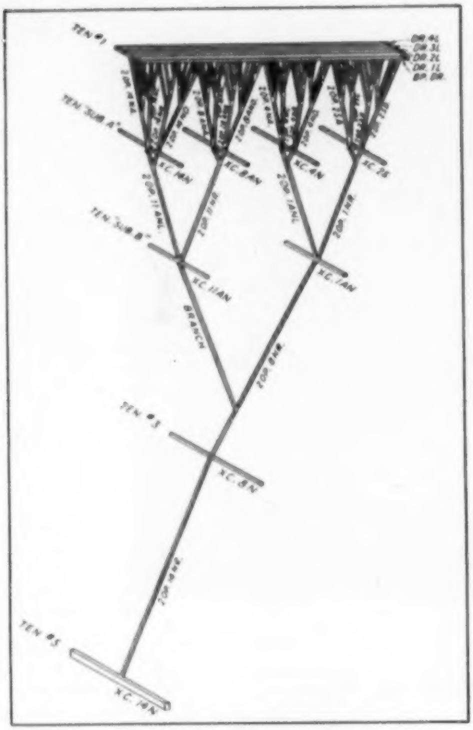


Fig. 1—Typical Braden ore pass system.

American Smelting and Refining Company, financed the original installation of a 250-ton concentrator, a 100-hp hydroelectric power unit, the necessary campsite, and the underground development of the Fortuna orebody. Actual production started in 1906, and from that time until 1920 the capacity of installations was gradually increased, with a resulting yearly production of 1,600,000 tons of ore.

The existence of a larger lowgrade ore deposit, the Teniente, was established by prospecting beginning in 1903 and terminating in 1911. At this time, with the end of ore reserves in the Fortuna mine in sight, full scale development of the Teniente orebody started. This program resulted in initial production in 1915 of 60,000 tons yearly and was increased to the present yearly tonnage of 9,000,000 tons. The property now is serviced by a 45,000-kw hydroelectric power system and a 30-in. gauge railroad consisting of 72 km of trackage carrying 1,800,000 ton-km of freight yearly. Both steam and diesel locomotives are in service, with a program in effect for complete conversion to diesel type on the main line.

There are 1600 men on the mine payroll. This includes all phases of underground operation: mechanical, electrical, tonnage control, contract and time card accounting, and engineering departments. The Braden Copper Co., a subsidiary of the Kennecott Copper Corp., has built and maintained a number of townsites for operations and is directly responsible for the welfare of the 16,900 persons inhabiting the various localities. It also claims the distinction of having treated over 200 million tons of ore, and it is one of the few billion-dollar mining camps in existence.

The orebody extends around the periphery of an extinct explosive vent in crescent-shaped masses, which are limited on the inside by the tuff contact where they are of higher grade. The upper limit is formed by the bottom of the oxidized zone which is from 50 to 100 m below the surface. At one time the lower limit was believed to be the contact with the primary zone, but in recent years more efficient mining methods and a somewhat higher than expected grade of the primary ore make it likely that it will be of commercial value.

The explosive eruption that formed the Braden vent fractured the andesite porphyry surrounding its periphery to a width of 100 to 600 m. After the crater was refilled, the mineralizing solutions deposited copper minerals in the fractures, and these again were the channels which aided the secondary enrichment. The main primary mineral is chalcopyrite, while the principal secondary mineral is chalcocite.

Mining Methods

Access to the mine is through the haulage adit 2.6 km in length, at which point are located two 500-m shafts. There are additional haulage drifts to the various ore chutes, all haulage drifts and adits being lined with concrete sets. The two 3-compartment shafts service production and sublevels. For men and materials there is also one auxiliary shaft servicing the production levels. Three inclines are in active operation, two for servicing the control sublevels and the third for removing contaminated air in connection with the mine ventilation.

Mining methods have changed greatly through the years, the first being the sorting and shipping of high grade ore, probably cuprite. This type of mining was practiced by the Spaniards. In the Fortuna mine, the original method was mining by shrinkage stopes and later a combination of shrinkage stopes followed by the caving of the intermediate pillars. When the present Teniente mine was put into production the method employed was the same as in the Fortuna mine. Subsequent mining

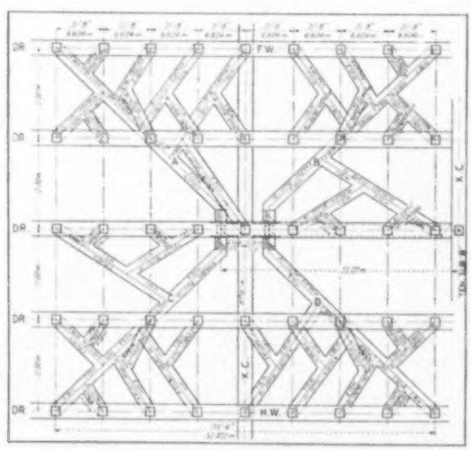


Fig. 2—Standard 45 Buitras ore pass system with ore passes independent, Braden Copper Co., Rancagua, Chile.

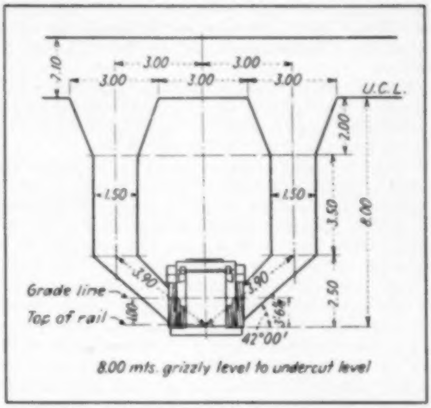


Fig. 3—Cross-section of finger raises in mining method used by Braden Copper Co., Rancagua, Chile.

practice developed the progressive block caving method in conjunction with shrinkage stope-pillar caving areas and eventually resulted in the progressive caving method directly on the drift timber.

At the present, progressive caving on an 8 or 9-m pillar is employed. The topography of the area is advantageous in that no hoisting of ore or pumping of water is required. Men and materials are transported on the haulage level and hoisted to the various sub and production levels. Ore is passed by gravity through a series of connected gathering raises to the haulage level, as illustrated in Fig. 1. Fragmentation of the ore in transfer to the haulage level by gravity is equivalent to a primary crushing operation.

Production Levels: At the present time four production levels are maintained to assure flexibility of operation. The drifts are driven center to center at 12 m with Ingersoll-Rand J-50 jackhammers mounted on a 3-in. col. and crossarm. Mucking is accomplished by Gardner-Denver 9 or Eimco 12-B mechanical shovels. The drifts are driven 6x7½ ft, and 10 to 12 holes are required, depending on the hardness of the ground. Miners are given two headings and drill and blast both headings in an 8-hr shift. They work on contract, and break about 3½ m per shift between the two headings. Since production levels are kept well in advance of caving operations, only one blast per day is required in each heading, which has proved to be a very economical procedure.

Before undercutting operations are started, drifts are timbered and grizzlies installed. Grizzlies are spaced 6.60 m center to center north and south along the production level drifts and 12 m center to center east and west. The gathering systems driven from the level 60 m below are stopped 2½ m under the production level floor, see Fig. 2. Each grizzly corresponds to the location of the branches of the gathering system beneath. A winze is sunk to connect with the gathering system. Experience has proved that if raises are driven from below and directly connected to the production level drift an unusually large opening results, and this is prevented by sinking the winze. All drifts are timbered with native lumber. Between draw points 8x8-in. sets are used, while 12x12-in. sets are placed at all draw points.

Undercutting: Undercutting blocks are laid out over an area, usually 60 m by 60 m, with a vertical lift of approximately 110 m. This is equivalent to about one million short tons of caved ore. The supporting undercut pillar is 8 m in thickness and is honeycombed by drawpoint chimneys on the undercut level floor, as shown in Fig. 3. Pillars on the undercut horizon are blocked out by drifts and crosscuts. Pillar drilling, see Fig. 4, is done with CF-89 Gardner-Denver drifters using 1¼-in. round steel with 4-ft changes up to 12 ft, and 5-L Liddicoat bits. Blasting is done with Gelamite No. 2, 40 pct powder, and Atlas Manasite No. 6 detonators and fuse. Undercut crews consist of six miners and three helpers and blast 162 sq m of undercut area daily.

In most sections of the Braden mine actual caving of the undercut rock does not begin until 36 m of width over the length of the block have been undercut. Rapid undercutting is therefore of utmost importance. Before caving is induced, the weight of the unsupported ground is transmitted to the areas adjoining the undercut area. If this weight is allowed to remain, the supporting pillar between the undercut floor and the production level will be crushed and destroyed and the weight supported by the production level timber, with subsequent high maintenance cost during operation. It has been found that two crews, each taking a slice 18 m in length on opposite sides of the entrance drift, can work safely and reduce by half the time needed for undercutting the first 36 m of width. This has now become the standard undercutting practice. When two undercutting crews are employed, an area of 60 m by 36 m can be undercut in 7 days and an initial cave obtained.

The moment caving has started, chutepullers begin the extraction of ore, drawing all undercut chutes with the exception of those in proximity of the undercutting crews. These chutes must remain closed to insure the safety of the men in the undercut. As the work progresses more draw points are opened for draw and every effort is made to induce a rapid cave. This eliminates the excess weight caused by arching and prevents damage to the pillar between the undercut and production levels.

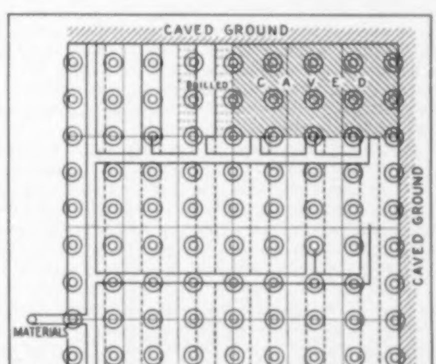


Fig. 4—Modified Braden mining method showing progress of development in widening and caving. Scale 1: 200.

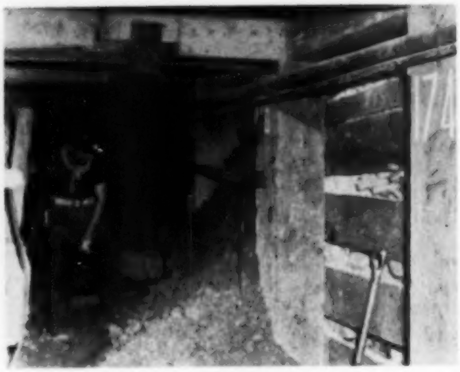


Fig. 5—Drawing of ore on production level.

Draw Control: The drawing of ore as shown in Fig. 5 begins when the undercutting over the production level has progressed to the point when caving starts. Drawing is done by chutepullers who are required to do any necessary secondary drilling and blasting. They also place charges when large boulders that hang up in the chimneys cannot be reached by 12-ft drill steel. These men work on contract and are paid an established price per ton of ore drawn.

Depending on the nature of the rock, the tonnages per chutepuller during an 8-hr shift may vary from 60 to 100 tons during the first 10 pct extraction. This figure increases to 400 tons at 35 pct extraction and goes as high as 2000 tons at 80 pct plus extraction, with an average of 700 tons per manshift for the life of the block.

The consumption of dynamite per ton of ore in secondary blasting decreases with increasing extraction. At 70 to 80 pct extraction it is normal practice to produce 13,000 to 15,000 tons per production level using only 10 to 15 lb of dynamite. Under these conditions a crew of four chutepullers per shift for each production level is required.

Draw control is of the utmost importance in block caving, and at Braden every care is taken in this direction. Draw charts (visual bar-graphs) for every drift are brought up to date twice weekly by the Tonnage Control Office. In addition to this, the mine foreman controls his daily extraction for the block. These two factors enable him to control the draw, bringing the block down evenly, and preventing the possibility of dilution.

All blocks are pulled so the side next to virgin ground reaches 35 pct extraction before the side next to the waste area. The first pair of chutes next to virgin ground side are closed at 35 pct extraction, the second pair closed at 47 pct, and the third pair at 60 pct. This procedure creates a barrier of 18 m in width, which prevents waste from being drawn in when the next block is undercut. These barriers are always maintained next to the virgin ground whether there are one or more sides.

Each gathering system collects the ore from an area 60x60 m. Within this area there are 45 grizzlies with two draw chimneys each, making a total of 90 draw points per gathering system. All main legs and branches in the gathering system are calibrated for volume on a tonnage basis. These systems are filled from the draw points on the production level by the chutepullers, under the direction of the mine foreman. The systems are then emptied, and this procedure is repeated until the desired tonnage is obtained.

Once the entire block is under draw, every effort is made to draw at a fast rate, about 3 tons per sq m of undercut area each 24 hr. One gathering system will produce about 10,000 tons per 24 hr.

It has been found that a fast undercut and a fast draw up to 35 pct extraction are the two factors which prevent arching and consequent pillar failure and give satisfactory fragmentation during the life of the block. Failure to do this not only results in increased timber maintenance, pulling in of waste suckers, and loss of copper extraction, but also lowers the overall tons per chutepuller shift. In the event of pillar failure and resultant timber failure on the grizzly level, a heavy draw is placed on the affected area to reduce the weight. Stulling, cross-bracing, lining the sets, and placing intermediate false sets will usually keep draw points open for draw until it is desirable to replace the timber. Timber consumption is less than three-tenths of a board-ft per ton of ore drawn.

During the four winter months milling is somewhat curtailed by a shortage of water and power, but during a favorable year the total tonnage may exceed 10 million wet tons. Ore passes and gathering systems have a reserve capacity to supply the mill for 24 hr.

Ore Delivery: The electric haulage system consists of 4½ km of 30-in. gage underground trackage, see Figs. 6 and 7. Four ore trains are used in tandem, each train consisting of one 30-ton locomotive and twelve 25-ton ore cars. Enclosed passenger trains convey the shifts to and from Sewell, transporting 52,000 passengers per month, see Fig. 8. The railroad has a haulage capacity of 950,000 tons per month and has hauled as much as 36,000 tons during a 24-hr period.

Ore trains are loaded at the ore passes by manually operated arc gates. Under normal conditions a train of twelve 25-ton cars can be loaded in 3 min. All train movement is controlled by a dispatcher. A round trip from loading chute to mill ore bins requires about 45 min.

Safety

Intensive safety training of all personnel at Braden Copper Co. has been carried on through the years and has yielded excellent results. It is im-

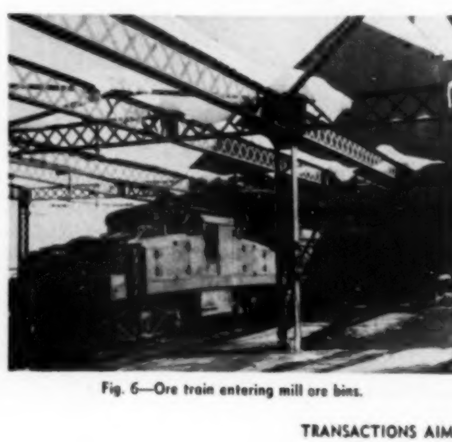


Fig. 6—Ore train entering mill ore bins.

possible to compare accident rates between mining operations unless the type of mining involved is considered. Table I illustrates the rates for different types of mining.

Table I. Accident Rates in the United States in 1947 and at Braden Copper Co., Chile, 1945 to 1947

Method of Mining	Rate Per Million Man-Hr Worked: Killed	Rate Per Million Man-Hr Worked: Injured
Top slicing	0.45	20
Sublevel caving	0.63	25
Square set	1.28	133
Open stopes	1.36	80
Cut and fill	1.63	103
Shrinkage stopes	2.25	122
Block caving	2.73	143
Braden block caving for years 1945 to 1947	0.35	53.4

While Chileans are excellent workers, a large majority of the personnel has had little or no previous mining experience. Consequently the low accident rates indicate a successful accident prevention campaign. The mine department operated consecutively 27 months with 11,423,021 man-hr of exposure and a production of 17,421,600 tons of ore without a fatality. During four consecutive years, 1947-1950, Braden Copper Company has been awarded the Inter-American Safety Plaque for attaining the lowest frequency of accidents in its group classification in Latin American countries.

Mine Rescue Training: Twelve crews of selected men holding medical certificates of physical and mental fitness are trained at monthly intervals in the use of oxygen-breathing apparatus and other equipment, and approximately 150 men from all sections of the mine are trained annually in first aid.

Ventilation: For the purpose of maintaining dust counts within permissible limits, seven fans with capacities ranging from 175,000 to 50,000 cfm have been installed. In so far as possible the ventilation of each level is operated independently. A split system permits fresh-air supply to each of the major production areas. Each drift in the production levels is also provided with an independent and regulated fresh-air supply. A total of 86 ventilation control points has been established throughout the mine, where monthly surveys furnish a check of the ventilation system.

Dust Control: The mine is comparatively dry; consequently the tonnages dropped by gravity and

Fig. 7—Haulage level showing loaded ore train.

Fig. 8—Passenger train at portal of haulage level.

the drilling and blasting of approximately 4000 shots per day present dust problems that are extremely difficult to combat. The results obtained at Braden in the suppression of dust can be attributed to the following measures: 1—Adequate ventilation for the removal of dust and gas from the various levels. 2—The installation of water foggers in all development headings and undercutting operations. 3—Wet drilling. 4—Blasting of undercuts and development work regulated to the end of the shift. 5—Wetting down before and during mucking operations and sprinkling down of all drifts where dust is present. 6—Provision of approved respirators to all men employed in dusty operations.

Fire Protection: In order to minimize the hazard of underground mine fires, the following precautions have been taken: 1—Complete fireproofing of all underground offices and shops. 2—Adequate fire-control equipment, such as water hydrants and portable fire extinguishers. 3—Metal containers with self-closing lids for the disposal of combustible material. 4—Underground oil storages and electrical distribution stations set in concrete vaults of raw-rock sections and isolated by means of steel doors set in concrete frames. 5—The use of Pyranol oil in all underground electrical transformers. 6—Provision for rapid isolation of the three shafts of the mine by means of fire doors on the various levels, provided with sprinkling systems that can be set in operation by the hoisting engineers.

In the event of an underground fire, a powerful siren installed at the portal of the mine warns all persons who may be off shift, as well as officials of various departments. A dual alarm system warns personnel within the mine: 1—Light flashing consists of an automatic device for flashing lights on all levels of the mine, giving first the international fire signal, which is followed by long flashes indicating the level where the fire has been reported. 2—The stench system introduces a stench fluid, ethyl mercaptan, into the discharge air line leading to the mine, equivalent to about 6 cu cm per 1000 cu ft of air in circulation.

Fire drills are held at regular intervals, two or three times yearly, using the three standard methods for notifying underground personnel, telephone, light-flashing and stench, these drills being carried out with complete evacuation of mine personnel. All escapeways leading from the mine are marked with directional signs, and fire-procedure plans have been prepared so that orderly evacuation drills are conducted in a routine manner.

Power Facilities at a Modern Anthracite Open-Pit Mine

by Frederick C. Pearson, Albert Brown, and Emil R. Ermert

EARLY in 1946 the Shen-Penn Production Co., a subsidiary of the Philadelphia and Reading Coal and Iron Co., was organized to operate the Shenandoah Stripping, one of the largest open-pit anthracite mines in the world. This mine is located in the Western Middle Field near Shenandoah, Schuylkill County, Pa., and involves the removal of approximately 60,400,000 cu yd of overburden to permit the recovery of 9,200,000 gross tons of rough cleaned coal from an area 8000 ft long and 2700 ft wide, with a maximum depth of 400 ft. Operations began in August 1946, and within the next few years 31,811,000 cu yd of overburden and 2,994,000 gross tons of rough cleaned coal had been removed.

During the early days of open-pit mining operations, steam was the primary motive power. However, as the size of the equipment increased, so did the problems of fuel, water, labor, and maintenance. Because of its efficiency and convenience, electric power rapidly replaced steam. Later the modern diesel engine was developed, and today practically all stripping equipment is either electric, diesel-electric, or diesel-powered.

In locations where electric power is not readily available or where operations are scattered over a large area, diesel power is favored. At Shenandoah operations are highly concentrated in a relatively small area, and this fact, coupled with the availability of ample electric energy, indicated the selection of electric-powered equipment.

Since this was a new company, it was necessary to purchase every item, from the smallest tools to stripping shovels. Although the organization period was hampered by the postwar scarcity of materials, an excellent opportunity was afforded to set up a thoroughly modern plant. This paper will describe the power facilities, with particular emphasis on the more unusual features.

The substation is a major item in a power distribution system, and a simple arrangement utilizing high quality equipment is an excellent investment. With this in mind, a 3000-kva unit type substation was selected and installed. This unit is made up of three sections, which are assembled simply by bolting together the various sections and connecting the power leads, see Fig. 1.

The transformer proper, rated at 3000 kva, is oil-filled and nitrogen-sealed, having a 66,000-v Delta primary and 4160-v Wye secondary with a grounded neutral and 46-ohm ground resistor. The function of this resistor will be described later.

Electrical energy is purchased from a public utility and is delivered to the main substation at 66,000 v over one or the other of two incoming lines. These lines terminate on a high voltage switching section on which high voltage fuses and Thyrite lightning arresters are installed.

The outgoing feeder switching unit is made up of the following:

1—An auxiliary compartment consisting of potential and current transformers with necessary terminal blocks for connecting to power company metering equipment.

2—Another auxiliary compartment containing a control transformer, battery, and battery charger for the furnishing of power for tripping and reclosing of power circuit breakers. The assemblies in these auxiliary compartments are mounted on carriages that can be rolled in and out with ease. Potential transformers are readily accessible for inspection and fuse replacement. When withdrawn from the operating position they are completely de-energized and grounded.

3—Two feeder breaker compartments, each with a 1200-amp, 5000-v, solenoid-operated magneblast air circuit breaker, voltmeter, ammeter, overcurrent relays, and a ground relay. These power circuit breakers can be quickly and safely withdrawn or repaired. A built-in isolating mechanism is used for lowering the breaker to a transfer truck for repair or inspection or as a means of disconnecting the breaker from the source of power as an added precaution when working on power lines. Thus inspec-

F. C. PEARSON, Member AIME, Electrical Superintendent, and E. R. ERMERT, Member AIME, Chief Engineer, are with Shen-Penn Production Co., Shenandoah, Pa. ALBERT BROWN, who died April 8, 1952, was Electrical Engineer, Philadelphia and Reading Coal and Iron Co., Philadelphia.

Discussion on this paper, TP 3268F, may be sent (2 copies) to AIME before July 31, 1952. Manuscript, Nov. 26, 1951. New York Meeting, February 1952.

tion and maintenance on this type of equipment are greatly simplified.

There are two methods of supplying electric power to stripping equipment, one being the use of portable cable from the primary substation to the driven machine and the other, of course, a combination of overhead line from substation to a central point and portable cable beyond. Each method has its advantages and disadvantages.

The cost of a pole line is approximately 50 pct that of a portable cable of the same length and capacity, but unless the pole line can be placed originally in a position from which the work may be completed either without disturbing the line or by retreating the line as the work advances, it will be necessary to provide sufficient material to construct a second line while the first is still in use. Otherwise a shutdown will be necessary while the line is being relocated, and under these circumstances the cost advantage will be heavily in favor of the cable. The relative security of an overhead line from mechanical damage must be considered as well as its vulnerability to storm damage, particularly ice and wind.

Formerly the use of portable cable was curtailed because of the difficulty encountered in locating faults. However, with the advent of modern cable fault-detecting apparatus this disadvantage has been virtually eliminated.

At the project under discussion it was decided after careful planning to use the combination power transmission system. Power is transmitted from the main substation to various strategically located points about the operation through two overhead pole lines. The line serving the eastern pit consists of one 4160-v circuit 2500 ft long, while the line serving the western pit is 4100 ft long and consists of a two-circuit line of 1540 ft and a one-circuit line of 2560 ft.

Class 4, 35-ft, treated Southern yellow pine poles were used, occasionally as long as 60 ft where necessary to provide clearance for railroads, highways, and shovel crossings. A spacing of 100 ft between poles was decided upon to facilitate work during periods of ice loading and windstorms. Despite exceptionally severe storms in the past 2 years, there have been no shutdowns due to power failure on the lines.

Crossarms, made of fir, are 5 ft 7 in. long except where two circuits are carried on one pole, in which event the crossarms are 8 ft long. All crossarms, insulators, guy wires, and hardware were installed while the poles were on the ground, in most cases making it necessary for a lineman to climb the poles only twice, once when the wires were installed and again when they were sagged in.

All conductors are of seven-strand, 4-0 hard-drawn, bare copper wire, three for phase wires in each circuit and one grounded neutral for the ground protective system.

Bulldozers were used to clear the right of way for the pole lines so that all materials could be trucked to the place of installation. Wherever possible, pole holes were drilled by a 9-in. churn drill. In one shift of 7 hr a crew of two men on such a machine can drill from fifteen to twenty 5-ft holes.

It was planned that both these pole lines would serve for the greater part of the life of the operation and as they conflicted with the work in the final stages would be retreated toward the substation. At various points along the lines disconnecting switches were mounted on the poles to provide convenient taps for shovel switch houses and drill transformer stations.

Fig. 1—A 3000-kva 66,000-4160-v unit type main substation.

Although several types of flexible cable are used to transmit electric power, the one considered best from all viewpoints is the SHD, three-conductor, 5000-v cable. No. 4 is standard for all shovels, while No. 4-0 is used for trunk transmission lines. Cable is laid in convenient places throughout the operation and behind each shovel is carried from the edge to the center of the cut on standards to permit the customary two-side loading of trucks. Each standard consists of an L-beam base supporting a socket made of a section of 8-in. steel pipe. Into this socket is inserted the butt of a 30-ft pole carrying a block for rope attached to cable hanger. Smaller all-metal standards are used to carry cables over roadways in areas being drilled.

The basic cable construction consists of three rubber-insulated power wires, with a wrapped or braided sheath of tinned copper wires around the insulation of each power wire. The ground wires are laid in the valleys between the triangularly spaced power wires. A heavy reinforced outer jacket of neoprene completes the assembly. The purpose of the sheathing over the insulation of the phase conductors is to reduce the voltage stresses in the cable, to give protection to workmen should a fault occur while the cable is being handled, and to eliminate

Fig. 2—Cable fault locator in operation.

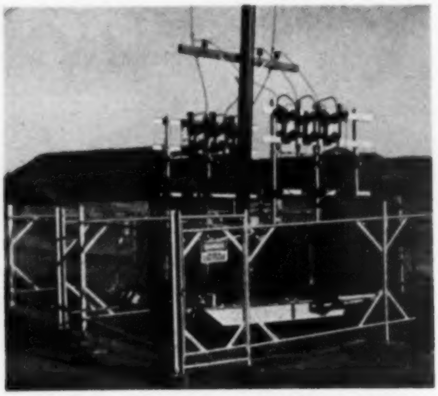


Fig. 3—Installation of two 150-kva 4160-480-v drill substations.

corona and the accompanying formation of ozone, which is injurious to rubber.

The ground wire in contact with the sheath has a total cross-sectional area equivalent to that of the power wires. Potheads, from which phase and ground wires extend about 30 in., are vulcanized on each end of the cable. Originally it was the practice to place stress cones on each conductor and to braid ground wires and sheaths together inside the potheads, but corona cutting of conductors operating the ground protective system resulted in delays, and later it was found necessary to extend the stress cones and sheaths outside the potheads.

On the drills type G 600-v cable is used, No. 4 size on single machines fed to a central point by a 2-0 cable. This cable is of construction similar to type SHD, but without sheathing.

Inasmuch as ground fault currents are limited by the ground fault resistor, ground faults frequently do not become visibly evident, and since a cable lying on the ground is subjected to a variety of hazards during a highly mechanized stripping operation, it is vitally necessary to test cables regularly so that the incipient faults can be located and corrected before probable shutdowns.

Soon after the commencement of work at this operation, information was received concerning a 10,000-v testing machine recently developed, and following consultation with the manufacturer a 15,000-v unit was designed for the work in progress. This proved very successful, and later two additional models were purchased. The cable tester locates faults in the insulation of electrical conductors and determines its condition by subjecting it to instantaneous high dc voltage. It is an impulse or surge device producing at intervals of 1 to 3 sec a loud cracking noise, much like a pistol shot, at the location of the fault. The basic component of this fault locator is a capacitor bank consisting of two 15-kv, 1-mfd capacitors. They are charged by means of a plate transformer and a rectifier tube. Two resistors are used to control the rate of charge to the capacitor bank, one allowing it to charge from 0 to 12 kv in 3 sec and the other from 0 to 7 kv in 30 sec. A 15-kv meter is included to indicate the voltage charge in the capacitor bank, see Fig. 2.

The output of the capacitor bank is connected to a fixed sphere, adjacent to which is a movable sphere that can be spaced from 0 to ¼ in. A third sphere is connected to ground and sheath at the output cable. The output cable is connected by Mueller clips to the cable to be tested. The sphere gap is adjusted so that the capacitor bank will discharge at about 2-sec intervals unless conditions dictate faster or slower firing time. If during the location of the fault the sound is not loud enough to be readily heard, opening the sphere gap will increase the intensity. This will also decrease the firing time interval. A thin blue spark at the sphere gap at intervals of several seconds indicates a good cable. To locate the fault in a defective cable, it is necessary only to locate the noise, no other instruments or calculations of any kind being required.

The 9-in. blasthole drills are usually operated in groups of from four to six machines, which are furnished with power at 480 v from a bank of 3-50-kva, 2300-v Wye-Delta connected transformers. These transformers are mounted on steel skids designed and built in the company shop. Included are two sets of disconnecting switches for power takeoffs for shovels, lightning arrestors, and cutouts for transformer protection. A bank of 90-kvar capacitors and a type AK1-15, 600-v, 225-amp, 15-kva interrupting capacity air circuit breaker are mounted in weatherproof steel enclosures.

Each station is enclosed by a steel mesh fence made up of six interchangeable sections each 10 ft long and 6 ft high, one section including a gate. The fence is bolted together by 36½-in. bolts and can be taken down or assembled in about 1 hr, see Fig. 3.

The subject of grounding has been receiving more and more attention. Electric shovels and machines of a similar nature are not located on permanent foundations and are usually supplied with electric energy at 2200 v or more, delivered to the machinery by a flexible trailing cable. When electric power first came into use for movable equipment, the portable cables developed had only three conductors. No provisions for ground connections were made since it was presumed that the machine would be well grounded because of the large area of contact of its tread on the ground. The fallacy of this assumption soon became apparent. Indeed, where the machine is resting on a rocky surface, the ground resistance may be so high as to practically insulate the machine from the ground. It is obvious that the occurrence of ground faults either on equipment or cables represents a serious threat to the safety of

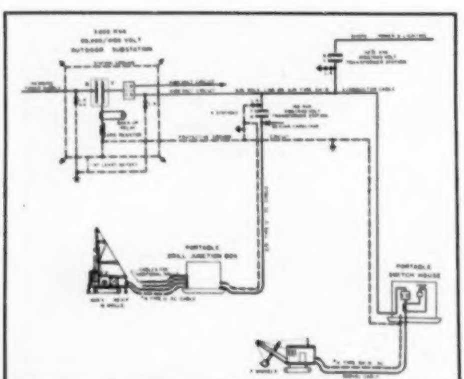


Fig. 4—Line diagram of power distribution system.

personnel unless suitable protection is provided. An electric current as small as 1/6 amp flowing for 1 sec can cause fatal injury, and an even smaller amount can cause loss of muscular control. These low currents can flow through the body at voltages as low as 100 if the skin is moist. Provisions must be made so that upon the occurrence of a ground, the ground fault current will be limited to a safe value and the faulty piece of equipment disconnected from the line as quickly as possible.

With ungrounded circuits, a ground fault on one-phase wire places the faulted conductor at ground potential. There is no interruption in the service, and the system may operate indefinitely with the existence of a single ground fault undiscovered. A second ground fault on another phase wire produces a short circuit, and a heavy fault current will flow, the amount depending upon the overall impedance of the circuit. If at the time of these faults a man standing on the ground should touch any part of a machine on the line, he would receive a severe or fatal shock.

The Impedance Grounded System is used by this company and is believed to be the most practical and positive system yet devised for protection against such hazards. Connections of the lowest practical impedance are provided between machine frame and ground, limiting the ground fault current to such a value that the voltage rise of the machine frame above ground potential will not exceed a voltage ordinarily considered safe for workers. Thus the fault circuit is disconnected as quickly as possible, see Fig. 4.

The frames of all shovels, switch houses, junction boxes, and portable transformer stations are connected by a ground wire to the substation and to driven grounds at intervals along the lines. All ground conductors have the same current carrying capacity as the phase conductors. This ground circuit resistance comes well within the 2-ohm limit considered a reliable value and assures adequate safety even if the ground resistance of these other paths is high.

A 50-amp, 46-ohm resistor and a current transformer are connected between the transformer neutral and the substation ground. The ground resistor limits the fault current to a safe value. The current transformer is connected to a relay arranged to trip the main feeder breaker with a short time delay. This is known as a back-up relay and operates only in the event that the relays in the portable switch houses to which each shovel is connected fail to operate. For example, disregarding reactance, if a fault should occur at the distant end of 3000 ft of 4-0 overhead line with a resistance of 0.0499 ohms per 1000 ft and 2000 ft of No. 4 cable with a resistance of 0.310 ohms per 1000 ft, giving a total resistance of 1.54 ohms, the voltage of the shovel frame above ground would be 77 v, a value well below the voltage considered dangerous.

In a small operation where only one shovel is supplied from the main substation, protective equipment at the substation is generally sufficient. However, on a multishovel operation, protection against dangerous voltages at shovel frames is lost if a second ground fault occurs at another machine before the first fault is cleared.

As ordinarily used, shovel cables are subject to rough use and so are liable to mechanical damage and insulation failure. Therefore the logical place to install protective devices capable of interrupting short circuits is at the point where the cables are connected to the relatively permanent feeder line.

Fig. 5—Skid-mounted shovel switch houses.

Switch gear and protective equipment for this purpose are carried in skid-mounted portable switch houses. The switch house is completely waterproof and is fitted with doors for access to the various compartments. The high voltage compartments are secured against entry by unauthorized persons. Inside are grouped disconnects, oil circuit breaker, ammeter, voltmeter, and necessary overcurrent and ground protective relays, see Fig. 5.

The protective scheme of the switch house differs somewhat from that used at the main substation. Should two lines to ground faults exist simultaneously on different phases at different locations, current of line to line short circuit magnitude will flow in the protective ground circuit between the two fault locations. This current is not limited by the neutral ground resistors and could produce unsafe voltages on the ground circuit. To avoid this possibility, it is necessary to depend on metering the unbalanced current in the three phases caused by the ground fault. This insures that in case of trouble on a given feeder, the actual feeder breaker involved will be tripped rather than some other feeder, as would be the case if there were a current transformer on the ground wire itself at the various switch houses. It is probable that the safety grounding of the secondary 480-v circuits will come into general practice in the future and will be accomplished in the same manner as that described above for the 4160-v circuits.

In the case of the 480-v circuits it is almost invariably necessary to deal with transformers that are delta-connected on the secondary, so that a zig-zag grounding transformer must be used to establish the neutral point. In addition, since no high voltages are involved and voltages need not be limited to ground to such a low percentage of the line voltage, a smaller maximum ground current may be used. Instead of the 50 amp usually used as the limit for ground current on the 2300 and 4160-v circuits, only 5 or 10 amp are used. This reduces the size of the grounding transformer and the grounding resistor while still insuring reliable tripping and sufficient protection.

Plans are now being prepared for placing all the 9-in. churn drills, operating in groups of four to six machines, under this ground protective system. To insure efficiency, all equipment and cables are in-

spected regularly. The insulation of all cables and the continuity of ground conductors are tested once every 2 months. The resistance of substation grounds is tested annually by the public utility, while the overcurrent and ground protective relays are tested semiannually. It is important that the ground protective equipment for each shovel be checked by applying intentional grounds at the time the cables are tested. Too much emphasis cannot be placed on this testing.

When cables are tested and found defective, they are repaired and vulcanized in the field. It usually requires 2½ hr to make a splice and about the same time for vulcanizing. If the damage occurs during working time, a temporary repair may be made to the conductors and the cable enclosed in a steel junction box 8 in. wide x 8 in. high x 36 in. long, skid-mounted. The cable is anchored by clamps and grounds are properly connected. This usually requires about ½ hr from the time the defective spot is found. If several repairs are to be made, the vulcanizing may safely be done later with the power in the cable.

When the shifting of shovels permits cables to be removed, they are taken to the repair shop to be inspected for cuts and bruises. The 5000-v cables are subjected to a 15,000-v test and the 600-v cables to a 5000-v test. Upon completion of any necessary repairs, the cables are placed on reels ready for use. Needless to say, with this systematic repair and maintenance program, shutdown time due to cable failure has been negligible.

Two cable vulcanizers are used, one being a small direct heat type that takes cords and cables up to ¾ in. in diam and the other a steam type that accommodates cables up to 4 in. in diam. Both are electrically heated, with automatic temperature controls, and are simple to operate.

Two types of compounds are in use for vulcanizing cables. One is the insulating compound in rolls both vulcanized and unvulcanized, while the other is the black outside jacket compound, which assumes the mould form when vulcanized.

The large 5 kw 440-v vulcanizer, which weighs about 365 lb, is mounted on a steel stand equipped with casters so that it may be readily moved about the shop. Underneath is mounted a 5 kw 110-220-v

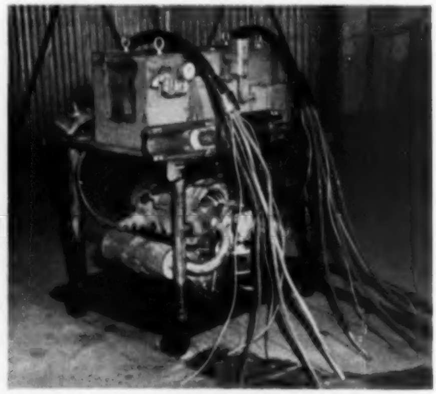


Fig. 6—A 5 KW 440-v cable vulcanizer. Type G cable at left prepared for pothead with a completed pothead at right. Self-contained power supply mounted beneath.

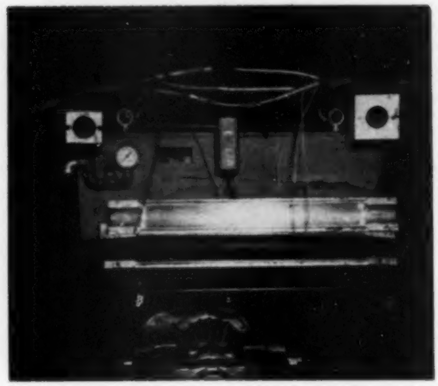


Fig. 7—Upper cable, type SHD: Lower conductor spliced with sleeve, upper conductor with insulation, center conductor complete with sheathing. Lower cable: Completed splice with moulds.

gas engine driven power plant and a 5 kw 440-110-220-v transformer. When used in the shop, the unit is connected directly to the 440-v building circuit and when used in the field is entirely self-contained. Auxiliary outlets are provided for connecting soldering irons, buffers, and heat lamps, see Figs. 6 and 7.

Fittings are arranged so that the entire unit may be attached to one of the pole line trucks for rapid and easy transportation to the scene of any trouble. Telescoping brackets are also mounted on the truck, over which a canvas covering is fastened for cable repairs in stormy weather.

Accurate logs are maintained covering electric motors, generators, and other major electrical apparatus on all the equipment. Reference to these logs gives an indication of the internal condition of the apparatus so that upon the occurrence of idle time through breakdown or other causes an excellent opportunity is afforded to examine and possibly overhaul items which may soon give trouble. This policy has often uncovered developing faults which can be economically and quickly repaired if detected at an early stage.

All the electrical work is carried on from a modern electric shop. This is an insulated, 32x56-ft steel building with a concrete floor. Ample facilities and equipment are included to handle all types of electrical repair work, and storage space is alloted for pole line trucks.

The total connected load at Shenandoah Stripping is 3629 hp. The average 15-min demand at the main substation is at present 1640 kw at 80 pct power factor. Since none of the equipment in operation is synchronous motor driven, power factor conditions were not of the best. The churn drills, driven by 40-hp induction motors, are normally about 50 pct loaded when drilling, and to compensate for the effect of this type of load on the power factor, 90-kvar, 440-v, outdoor-enclosed, three-phase capacitors were installed on each of the five 150-kva, 4160-480-v transformer banks supplying the power to the drills operating from four to six per bank. This improved the power factor from 67 pct to the present 80 pct. Further improvement is contemplated for the immediate future by the installation of 2400-v capacitors on the overhead lines supplying power to the shovels.

Geology of the Silver-Lead-Zinc Deposits of The Avalos-Providencia District of Mexico

by W. H. Triplett

Silver-lead-zinc replacement deposits occur in limestones of the anticlinal Caja range at Providencia, near Avalos, Zacatecas, Mexico. The description deals with intrusives, outcrops, preferred horizons, changes from bedding to fracture, control in depth, and variations in abundance and ratios of minerals throughout a vertical range of 500 m.

THE purpose of this paper is to record a few field observations and accumulated office data concerning outcrops, relation of ore occurrences to intrusive and host rock, and mineral zoning. Reasons for some of the phenomena are not clear to the author so the facts are given with the hope that other investigators may be able to furnish the explanations.

The Avalos unit of the Compania Minera de Penoles, S. A., operates the Alicante, Bonanza, Providencia, Albarradon, San Eligio, Nazareno, Leona, Salaverna, and Santiago mines situated between Avalos railroad station and Concepcion del Oro on the Coahuila and Zacatecas railroad in the State of Zacatecas, Mexico. Some of these mines are within Penoles property while others are on mining claims leased from the Compania Nazareno y Catasillas, S. A., Mazapil Copper Co., and the American Smelting and Refining Co. The main office and camp are at Providencia, about 170 km southwest of Monterrey, N. L., so the silver-lead-zinc mines of the district are usually referred to as the Providencia mines.

The Aranzazu, Catarroyo, and Cabrestante copper-gold mines are situated a few kilometers to the southeast on the same mountain range near Concepcion del Oro, the name by which the camp is known. It is operated by the Mazapil Copper Co.

The main theme in the following pages is a description of the silver-lead-zinc ore occurrences of the district.

Rock Formations

Sedimentary Rocks: Many competent geologists have contributed generously to an ample fund of information concerning the sedimentary columns of northern Mexico. Among them are Carlos Burckhardt, E. Böse, L. B. Kellum, and R. W. Imlay. Carlos Burckhardt, who covered a number of extensive areas in many parts of the Mexican Republic, devoted years to mapping the geology of the Caja, Zuloaga, and Santa Rosa mountain ranges around Mazapil, Concepcion del Oro, and San Pedro de Ocampo, Zacatecas. He did most of the original mapping which has been used as a basis and amplified by others. C. E. Burbridge and, more recently, John

W. H. TRIPLETT, Member AIME, is with the Compania Minera de Penoles, S. A., Monterrey, Mex.

Discussion on this paper, TP 3304B, may be sent (2 copies) to AIME before July 31, 1952. Manuscript, Oct. 3, 1951. Mexico City Meeting, Oct. 29, 1951.

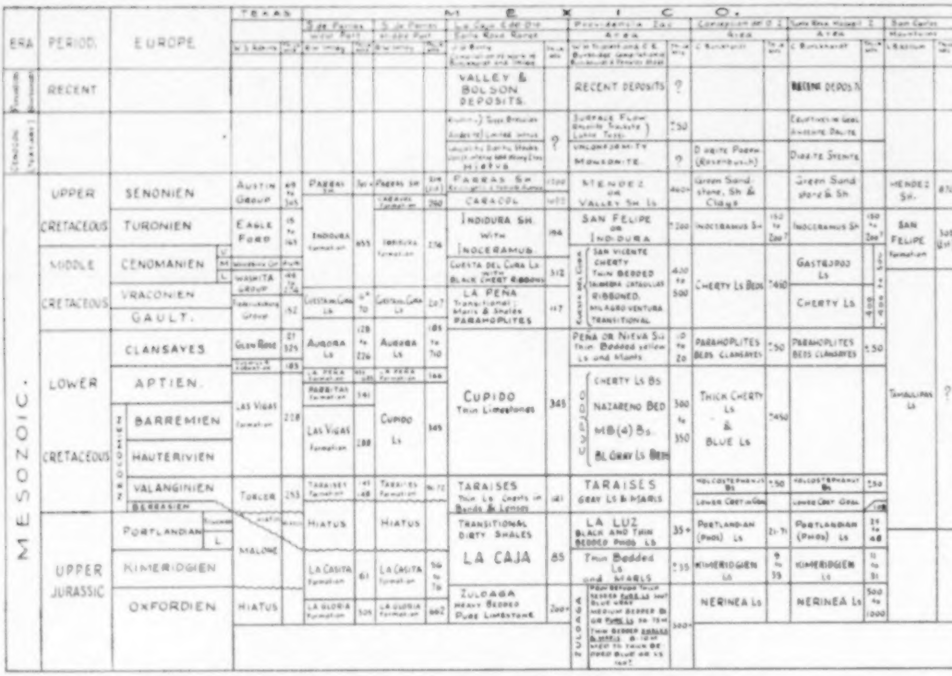


Fig. 1—Correlation of sedimentary formations of the Providencia, Concepcion del Oro, Santa Rosa, Mazapil, Aranzazu, and San Eligio Areas, Zacatecas, Mexico, with those of other Texan and Mexican areas.

G. Barry, compiled the data in the accompanying correlations of sedimentary strata, see Fig. 1.

Jurassic: Ore deposits of this district have occurred more abundantly in the Nerinea limestone of the Upper Jurassic than in any other formation. It is a moot question whether this abundance of mineral is due to the inherent physical and chemical qualities of the limestone or to its nearly uniform confined position between a large intrusive stock and overlying hornstones. The Nerinea limestone is very nearly pure calcium carbonate, light blue-gray in color, medium-bedded (0.5 to 1.0 m) and usually crystalline white near the intrusive. Here the bedding can be recognized only by stylolites. The thin-bedded overlying Kimeridgean hornstone, originally shaly limestone, and the dark-colored Portlandian limy phosphatic shale formation, each of which is 30 to 40 m thick, constitute a tight hanging wall for nearly all the San Eligio, Albarradon, and Providencia orebodies, see Figs. 2 and 3. There is almost no ore at all in the Kimeridgean and Portlandian even close to the channels of mineralization, in contrast with the abundance in the Nerinean limestone. Whether the marls and shales were less amenable to replacements than the pure limestone or acted as a retarding barrier to the circulation of mineralizers, or whether the selective action was due to both, or to some other influence, is a matter of opinion.

Lower Cretaceous: The Taraises limestone is yellowish gray to gray in color, stratified in beds usually 15 to 50 cm in thickness. It contains some impurities such as a little clay and occasional cherts. The San Marcos ore chimneys occur in this formation. The overlying Cupido limestone, blue-gray in color, is a purer limestone, with the exception of occasional beds of chert. The beds are usually 20 to 60 cm in thickness. The large Animas ore chimneys follow the steeply inclined bedding near the middle of this formation. Some smaller orebodies occur near the top of the Cupido under the Pena limy shales. The total thickness of the Taraises and the Cupido is about 450 m. These constitute the second and third important ore horizons.

The fourth important ore horizon is the upper part of the middle Cretaceous, the thin-bedded Cuesta del Cura or Cenomanian limestone. The strata are bluish gray to yellowish in color, 10 to 30 cm thick, consistently wavy with abundant black cherts. The Santiago, Salaverna, and San Vicente orebodies all occur near the top of these wavy limestones, just beneath the Indidura (Turonian) limy shales.

Upper Cretaceous: The Indidura or San Felipe formation, the lowest member of the Upper Cretaceous, consists of alternating thin beds of limestone, marl, and shale that break up into smooth flagstones in contrast to the wavy Cuesta del Cura cherty

Table I. Typical Specimen of Quartz Monzonite Taken Away from Limestone Contact on Level 5

Essential Minerals, Pct		Accessory, Pct		Alteration Products	Introduced Minerals
Plag.-Andesine	40	Biotite	4	Chlorite	Pyrite
Orthoclase	30	Magnetite		Sericite	
Quartz	15	Apatite		Epidote	
Pale Hornblende	5			Leucoxene	
				Titanite and Rutile	

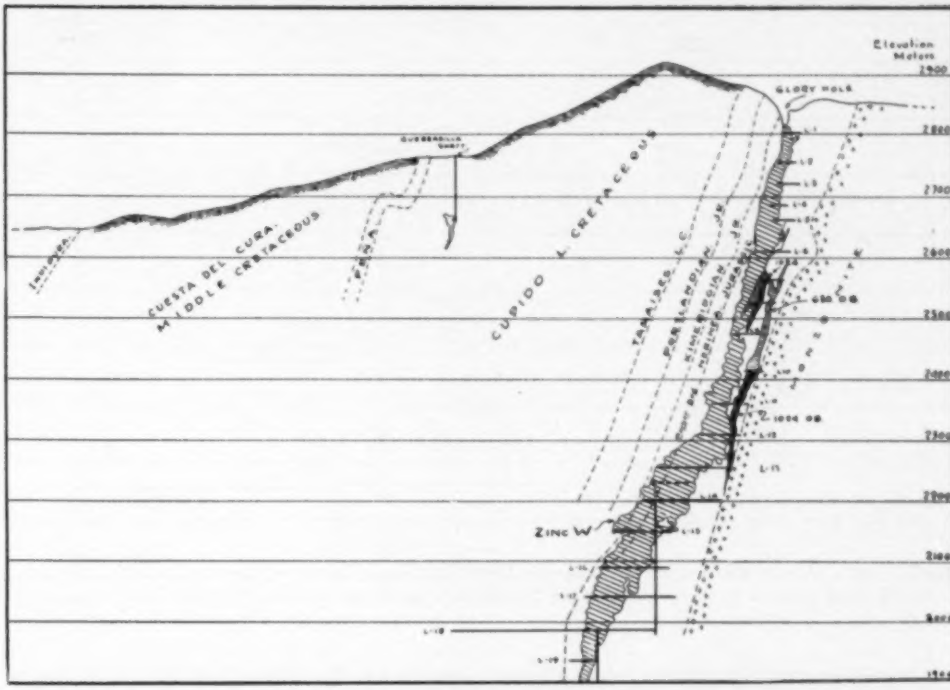


Fig. 2—N. 30° E. projection looking N. 60° W. at the Zinc West, 1024, and 630 orebodies in the Jurassic limestones. The overlying middle and lower Cretaceous are also shown. Mines of the Cia. Minera de Penoles, S. A., and Cia Minera Nazareno y Catasillas. Providencia, Avalos, Zacatecas. Scale 1:5000.

limestones. It can be identified by numerous inocerami. Its lowest shaly beds constitute the hanging wall of some of the Santiago orebodies and apparently guide them to the outcrops, see Fig. 3. One small but high grade silver-lead-zinc orebody, the San Gregorio, occurs in the Indidura formation where the sulphides replace the limy members.

Practically all of the important limestone replacement ore deposits of Mexico occur in the lower Jurassic, lower Cretaceous, and middle Cretaceous formations described above. A few of the smaller replacement deposits are found in the Indidura or San Felipe limy shales. The silver-lead deposits in the San Carlos Mountains of Tamaulipas, described by L. B. Kellum, are examples. Overlying the Indidura formation there is a very thick series of shales known by various names, Senonien, Parras, and Mendez. They are widespread over northeastern, eastern, and central Mexico, but so far as is known no important replacement ore deposits have been found in them.

Intrusive Rocks: A number of intrusive masses crop out in the Caja Range, but only two of these are closely associated with the largest ore deposits, see Fig. 4. These are the diorite stock at Concepcion del Oro and the quartz monzonite stock forming Temeroso peak near Providencia. These are very much alike petrographically and are probably connected underground, forming one continuous mass. Frank F. Grout's report on a typical specimen of the quartz monzonite taken away from the limestone contact on level 5 is given in Table I.

The diorite stock around which are clustered the Cabrestante, Catarroyo, and Aranzazu deposits is the high temperature end of the district. Here the intrusive is enclosed in an envelope of epidote and garnet many meters in thickness, and the baking and alteration of the sedimentary rocks extend far back into the walls. Contact metamorphism around the Providencia quartz-monzonite intrusive is much less intense. The envelope of epidote and garnet is only 1 or 2 m thick. The limestone near the contact is recrystallized but still pure limestone. The limy shale beds, which roughly parallel the contact at 120 to 200 m distance, have been converted to a very hard, tight, overlying wall of thin-bedded hornstone and slates.

In the Salaverna area there are several dikes and sills, which vary in character from monzonite to quartz porphyry. Northwest of the Providencia-Refugio-Rusio area, near Mascaron peak, there is a rhyolite plug. Monzonites outcrop along a great normal fault, which runs along the northeast side of the Caja range, but they have not yet all been plotted on Fig. 4.

Extrusive Rocks: The above sedimentaries and intrusives, which were uplifted to form the Caja mountain range, were eroded down to such an extent that both the lowest Jurassic limestones and the intrusive rocks were exposed on an eroded surface before the extrusives were laid down, see Fig. 4. The latter consists of rhyolite tuffs with variations toward latite. The extrusives are premineral as far as one minor

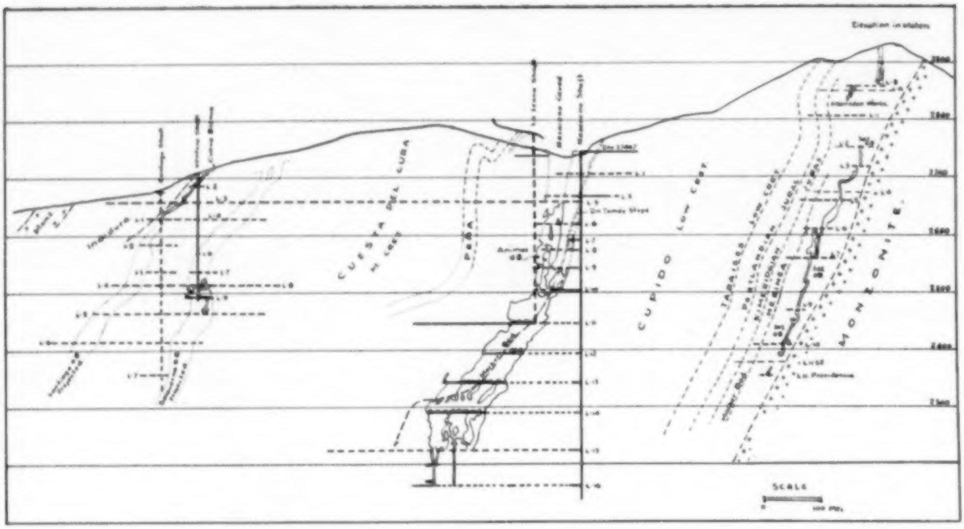


Fig. 3—N. 33° W. projection looking N. 57° W. at Albarradon, Las Animas, Salaverna, Santiago, and Cueva Blanca orebodies. Mines of the Cia. Minera de Penoles, S. A., Cia. Minera Nazareno y Catasillas, S. A., and Mazapil Copper Co., Providencia, Avalos, Zacatecas.

ore shoot is concerned, but it is not known whether or not they predate all of the orebodies. Before erosion they covered and possibly sealed the narrow, steeply dipping corridor between the monzonite foot wall and the hornstone hanging wall, where the San Elias, Albarradon, Providencia, Bonanza, Alicante, and other chimneys are located, see Figs. 2 and 3. Most of the extrusives have been eroded, but there still remain a few isolated remnants capping some of the higher peaks along the southwest side of the Caja Range.

Regional Structure

The Bonanza-Providencia-San Elias-Animas-Salaverna and smaller groups of silver-lead-zinc deposits, the Concepcion del Oro copper-gold and the Santa Rosa lead-gold deposits all occur at a pronounced bend in the mountain chains where they change strike from northwest to west. The axis of this bend strikes northeast from this district through the Diente mine near Monterrey. All of the mountain chains between these two districts bend concentrically around the region herein described. The ranges are successive anticlines and synclines, many of which are slightly overturned toward the northeast, see Fig. 5.

In the Mazapil district the Concepcion del Oro diorites, the Providencia monzonites, and the Santa Rosa rhyolites have welled up within the anticlinal folds but are confined in most parts of the district under the Jurassic limestones, see Fig. 4. In the Caja Range there are discontinuous outcrops of intrusives from Concepcion del Oro through Providencia to the Noche Buena and San Francisco del Alto mine, a distance of about 28 km. Faulting is of minor importance as compared to the intense folding. There are a few faults in the southeastern end of the range at Concepcion del Oro and also from Milanesa peak westward to San Francisco del Alto, but almost no faulting from the Aranzazu mine to Milanesa peak. Between these two points, the sedimentaries have been uplifted so evenly in a N. 55° W. line almost parallel to the intrusive contact that the marker beds can be followed with relative ease. It is in this least disturbed belt that mineralization has been most intense, particularly the silver-lead-zinc mineralization, see Fig. 6.

Local Structure

Jurassic Limestone Belt: The Aranzazu copper mine and the San Eligio, Albarradon, Providencia, Bonanza, Alicante, and Rusio silver-lead-zinc mines all occur in the narrow band of Nerinean (Jurassic) limestone along the southwest side of the diorite and monzonite intrusives. The narrow band, which dips 60° to 70° to the southwest, is confined between the intrusives and the overlying Kimeridgian hornstone. This is the most productive belt of the two camps. Fig. 2 shows a vertical N. 30° E. projection of the formation and the Providencia orebodies including the Zinc West stope.

The Cretaceous limestones overlying to the southwest are productive but to a lesser degree, as described under Rock Formations. The northeast limb of the anticlinal fold on the other side of the intrusives is almost vertical or slightly overturned. Very little mineralization and no mines have been found on the northeast limb, except at Noche Buena and San Francisco del Alto, 28 km to the northwest of Concepcion del Oro.

There are myriads of small to tiny fractures, mostly N. 10 W. to N. 80 E., running outward from the intrusive. The N. 30 E. fractures, which are normal to the igneous contact and to the strata, and the N. 70° to 80° E. fractures are the only ones that have been definitely proved to be mineralized in depth. Shrink-

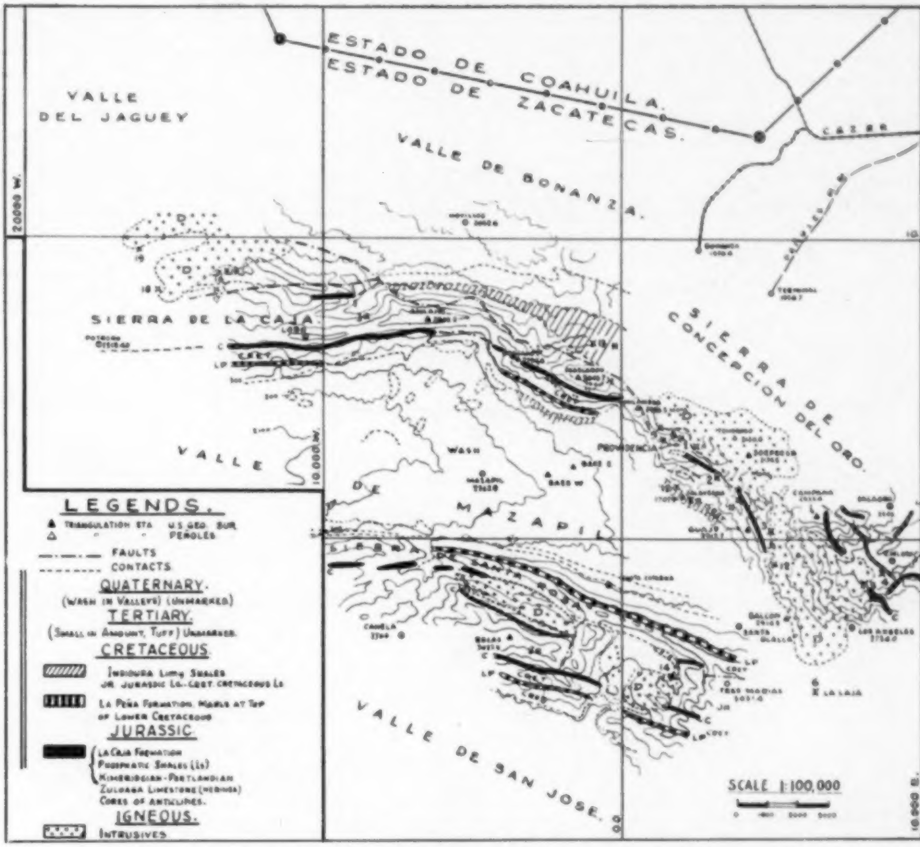


Fig. 4—Sketch of the Caja and Santa Rosa mountain ranges in the Mazapil region, showing important mine openings.[1-7]

1—Providencia Tunnel (Penoles). 2—San Eligio Shaft (Mazapil). 3—General Adit, Aranzazu (Mazapil). 4—Cabrestante Shaft (Mazapil). 5—Cata Arroyo Shaft (Mazapil). 6—La Laja Mine. 7—Santiago Shaft (Nazareno). 8—Refugio Tunnel (American Smelting and Refining Company). 9—Rucio Mine (Mazapil). 10—San Vincente Shaft (Mazapil). 11—San Marcos Mine. 12—San Antonio Adit, Aranzazu (Mazapil). 13—Siempre Adelante Mine. 14—Santa Rosa Shaft. 15—Noche Buena Adit. 16—Chivo Entrance (Noche Buena). 17—Manganeso Prospect (Noche Buena). 18—San Francisco del Alto Mine (Nazareno). 19—Portrero Adit (Mazapil).

age of the intrusives has opened up the N. 55 W. bedding planes of the steeply inclined limestones on the upper levels but not on the Providencia levels below level 11, which is about 550 m below the outcrops. They become increasingly tight on each succeeding deeper level.

A series of level maps of the Zinc West area, see Fig. 7, shows the channels that carried mineralization from level 20 upward. These channels are along N. 25° to 30° E. fractures on the lower levels, but when the mineralization reached the vicinity of level 12, the opening and loosening bedding planes apparently became the channels of least resistance, and the mineral carriers changed over to N. 55° W. beds in preference to the N. 30° E. fissures. On the upper levels some of the orebodies are either tabular replacement bodies conforming in strike and dip with the Nerinean limestone or are steeply inclined chimneys, which are lenticular in horizontal section.

The Alicante-Refugio-Albarradon and San Eligio orebodies, all of which are in the narrow band of Jurassic limestone between the intrusive and the Kimmeridgian hornstone, are similar in structural characteristics to the Providencia bodies, but the predominant mineralized cross fissures strike N. 70° to 80° E.

Nazareno-Leona Area: The Animas silver-lead-zinc body is an oval-shaped cluster of pipes with a combined horizontal ore cross-section of 700 to 800 sq m, see Fig. 3. The pipes have been followed steeply downward to a depth of about 600 m and have stayed with the same beds most of the way. At one place near the 14th level, where the beds flatten out in a minor monoclinal bend, the ore chimneys go down almost vertically through the flat beds until the beds regain their normal steep dip. At this point the best root rakes off along a series of beds flatly to the northwest. There are numerous insignificant cross fractures, but the ore does not take shape on any of them. The only fissure on which ore occurs is a strike fissure on the upper levels. The bedding served as a guide on the upper levels but no reliable guide has

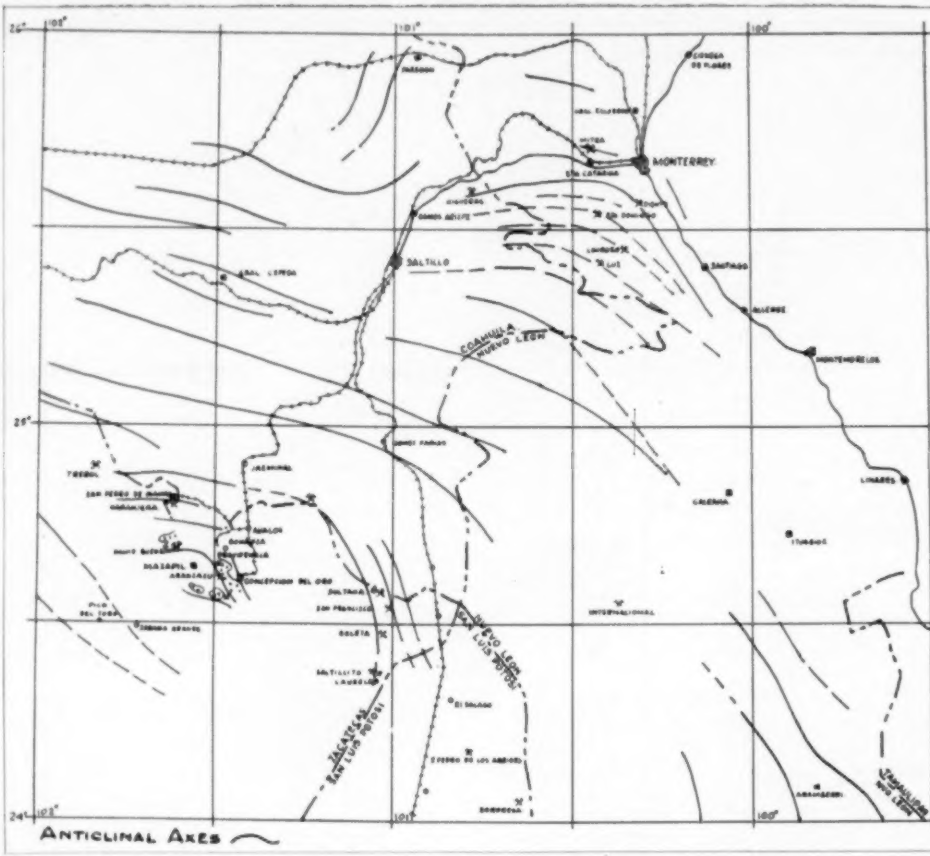


Fig. 5—Approximate locations of mining camps in the bends of the mountain ranges between Providencia, Concepcion del Oro, and Monterrey, Mexico.[7] Scale 1:1.000.000.

been found on the lower levels. The staff is still wrestling with the vagaries of the occurrence and wondering where the ore came from.

Salaverna-Santiago Group: There are four branches of the Santiago Zn-Ag-Pb orebody which crop out along the contact between the Cuesta del Cura cherty limestone and the Indidura shaly limestones, see Fig. 3. The sedimentaries are intensely folded and irregular, but the branches were followed downward approximately along the contact until they came together into one larger body. They are now being worked downward, but they go down a little more steeply than the bedding. The Salaverna is a single irregular body in the intensely folded Cuesta del Cura limestone. Though steeper than the dip of the strata, the latter is the main guide in following the ore in depth.

These examples are characteristic of nearly all the silver-lead-zinc orebodies of the region. Except for a few cross fissures normal to the intrusive contact at great depth, the beds of limestone, silicified limy shales, and shales seem to have exerted the greatest control over mineralization and have proved the best guides in following ores. There are occasional minor bends or folds in the limestone that have caused local enlargements of some of the ore chimneys.

Silver-Lead-Zinc Ores

The greatest production of the district, by far, has come from the many steeply inclined chimneys in the Zuloaga (Nerinea) limestone corridor between the quartz-monzonite intrusive and the metamorphosed Kimeridgian limy shales. These hornstones form an extremely hard impermeable hanging wall dipping 60° to 70° to the southwest, see Figs. 2, 3, and 6.

It is not known whether the large main ore shoots are of post lava capping age or not, but there is one small ore shoot in the Luz mine which outcrops in the capping rock, so the other larger shoots may also have had an overlying felsite roof. Even though the larger bodies may have gone through the capping, this roof may also have had a retarding influence which tended to increase replacement in the underlying limestones.

On the upper levels, each ore shoot replacing a certain steeply inclined limestone bed or series of beds tended to stay with the same bedding as it was developed downward, but occasionally it stepped across into the foot wall to an underlying bed. Some of the smaller shoots, occasionally dipping more steeply than the strata, reached the intrusive con-

tact in the oxidized zone. At this point they consisted of masses of very low grade iron oxides.

Other chimneys, like the 1024 orebody of the Providencia mine, reached downward to the contact in the sulphide zone, where they terminated in masses of pyrite. There are no high temperature minerals in this body of pyrite, sphalerite, and galena, except the thin envelope of garnet, 1 to 2 m in thickness, which covers the whole intrusive. In the opinion of Frank Grout and G. M. Schwartz, specimens submitted to them are mesothermal to epithermal ores occurring during one general replacement period. In all specimens the pyrite was followed by sphalerite-chalcopyrite and finally galena. Rhodochrosite, calcite, and quartz followed the sulphides.

Some of the larger bodies were worked down the bedding to a greater depth, but below level 10 they were found to have been controlled more by N. 30° E. and N. 70° to 80° E. cross fractures than by N. 55° W. striking beds, see Fig. 7. On the bottom levels the only remaining influence of the bedding seems to be the limiting effect of the tight overlying hornstones. On the 20th level of the Providencia mine, about 1000 m below the outcrop, the Zinc West orebody lies along a N. 30° E. fracture under a hornstone hanging wall, and its minerals consist almost entirely of pyrite, with only a little sphalerite and very little galena. The sill floor of this still undeveloped pyritic mass is about 130 to 175 m projected distance from the intrusive contact.

Referring only to the orebodies in the narrow corridor between the intrusive and the hornstone hanging wall, the ore shoots are most numerous near the intrusive. They terminate with their roots at the igneous contact and contain more iron than those farther away. Many Alicante and Refugio and a few Providencia bodies are examples of this habit. The bodies farther away from the intrusive reach greater depths before becoming very pyritic and terminate only when the proportion of pyrite and unreplaced limestone renders them noncommercial.

The ore chimneys in the Cretaceous limestone farther away from the intrusive are still less numerous, but some of them are large, see Figs. 3 and 6. The Animas cluster of three shoots, which joined and separated repeatedly, was developed downward on steeply inclined bedding. A marker bed, see Fig. 3, shows definitely how closely the ore stayed in one group of limestone beds from the 14th level to the surface, but climbing across individual beds on the upper levels, to shorten its channel toward the surface. On the 14th level, there is a minor monoclinal bend through which the chimney rose vertically. Below the 15th level two of the shoots are being worked vertically downward while a third, apparently influenced by the monoclinal bend, is being

Fig. 6—Geological setting of Refugio, Providencia, San Eligio, Salaverna, San Marcos, Aranzazu, and Concepcion del Oro mining camps.

Q Quarternary.
RHY Rhyolite and Latite Capping.
UC Upper Cretaceous. {Mendez Shales. Indidura Limy Shales.}
NS Lower Cretaceous: Pena or Transitional Nieva Shale.
MC Middle Cretaceous: Cuesta del Cura Cherty Limestone.
LC Lower Cretaceous. {Cupido Limestone, Cherty Taraises Limestone.}
UP Upper Jurassic: Portlandian, Phosphatic Shales.
JK Upper Jurassic: Kimeridgian, Limy Shales.
JN Upper Jurassic; Nerinea, Zuloaga, and Providencia Limestone.

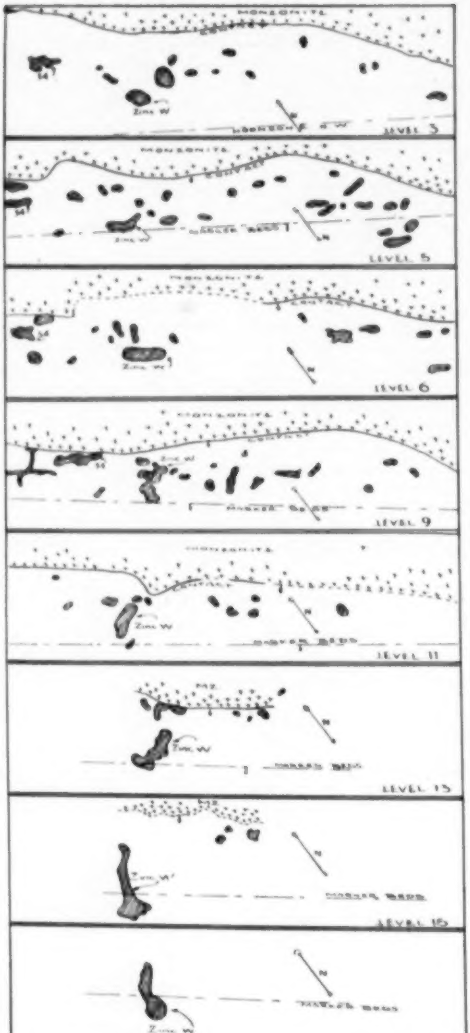


Fig. 7—Horizontal cross sections of Providencia and Alborradon ore chimneys. Cia. Minera Penoles, S. A. Scale 1:4000.

mined down its flatly inclined axis toward the northwest. On level 16 it is now 200 m away from the other two shoots near some cross fractures where the fold plays out. Especially interesting is the fact that recent diamond drilling has shown that the orebody again turns steeply downward at this change in structure. Up to the present stage of devlopment, the limestone bedding appears to have been the dominant control in channeling the mineralizers of the Animas group and several smaller bodies consistently close to a horizon identified by the marker beds.

Still farther southwest, about a kilometer away from the intrusive, there is another horizon of ore pipes near the top of the middle Cretaceous limestone, under a hanging wall of the Indidura limy shales. The Cuesta del Cura cherty limestone in which they occur together with the Indidura are intensely folded. The Santiago ore shoot lies close to the shaly hanging wall from the surface to level 4, but below that level the chimney dips more steeply than the average dip of the bedding. The Salaverna body outcrops in the Cuesta del Cura limestone further back from the Santiago. It sticks fairly close to its horizon but tends to dip more steeply than the average dip of the contorted limestones.

The San Gregorio orebody, from the outcrop to level 4, is in the Indidura limy shales, some of its impure limestone members having been replaced by pyrite, sphalerite, and galena. If past experience serves as a guide in this instance, it will be found stepping down across steeply inclined beds toward the Cuesta del Cura cherty limestone. This is the only known example of a commercial body of this camp outcropping in the Indidura limy shales, and if it does step down into the more favorable formation, the shoot may have a larger cross-section.

Outcrops

After years of scantily rewarded search for promising outcrops, one cannot help envying the Spanish colonists who began working the silver-lead mines about 400 years ago. According to bits of history that have come down to us, Indians guided Francisco Urdinola to the Bonanza and Providencia outcrops. Many of them were wide and continuous, some elongated in the direction of the steeply dipping strata. Iron oxides with an abundance of box work were found at the surface for some of the material can still be observed clinging to the walls of the open cuts. Diggings in the old dumps close to the surface workings yield yellow, orange, brown, maroon, and black iron oxides, both of the migrated type and the residual type with box work. Malachite and azurite stain and crystals are rather common, although the primary ores contain only a few tenths of one percent copper. Yellow jarosite, canary yellow to yellow-green mimetite, and pyromorphite are usually present. Occasional crystals of orange-colored wulfenite and white to yellow calamine can be observed. Silica is present as crystallized quartz and chalcedony, in iron-stained jasperiod, in zinc silicate abundant on the upper levels, and jaboncillo, a hydrous alumina silicate with considerable zinc and other elements of secondary origin also found in the oxidation zone. Calcite is abundant and gypsum rare. Cerussite is usually obscured by iron oxides. Fluorite is rare.

Some of the outcrops that have not responded to exploration contain abundant calcite and barite, but only small quantities of iron oxide, arsenates, cerussite, calamine, antimony oxides, sulphide, galena, and sphalerite. Occasionally there are a few specks of cinnabar. Quartz is often abundant. The conspicuous difference between the productive and unproductive outcrops is the relative abundance of iron oxides.

There are exceptions to this generalization, but not many. One that is hoped will turn out to be an exception is a mineral showing with very little iron, found by trenching through soil and caliche. All that

appeared at first was a faint barely noticeable gray streak an inch or two wide. As this streak was followed downward it took on a tabular form of recognizable minerals and widened gradually to 2 ft at 3 or 4 m depth. The mineral is mostly cerussite and anglesite, with a very few crystals of mimetite or pyromorphite, calamine, wulfenite, and galena. At the start a 10 cm width along the gray streak assayed:

Width, Cm	Au, G	Ag, G	Pb, Pct	Zn, Pct
10	1.3	2500	51.0	7.0

Trenching revealed three other similar prospects under covers of caliche. Samples from these assayed:

Width, Cm	Au, G	Ag, G	Pb, Pct	Zn, Pct
25	4.0	40	19.5	1.8
13	0.25	40	36.0	3.0
15	0.15	320	22.4	4.3

A meter or so below the surface the calichelike material takes another form, that of semidecomposed and leached thin-bedded silicious limestone with the normal dip to the southwest. The development of these four high grade stringers may yield some interesting information because the orebodies of this area, whose outcrops were reported to have been high grade in the shallow surface workings, assay only about 125 g silver, 3 to 4 pct lead, and about 15 pct zinc on the 5th and 6th levels. If these eventually go down into low grade sulphides with an abundance of pyrite and zinc, they will be fresh examples of shrinkage, collapse, and enrichment by secondary processes, which also altered the wall rocks and concealed the outcrop beneath the products of decay. They may, of course, lead to an entirely different type of ore shoot.

Trenching by hand is slow and costs $1.50 a lineal meter or $0.15 a sq meter of prospected surface area. A new method is now being tried out. Pits from ½ to 1 m deep are dug at 5-m intervals across a favorable limestone horizon. All samples have contained traces to a few tenths pct lead and from a few tenths to over 2 pct zinc. It is too soon to expect results from this new adventure.

Another type of outcrop, or rather a hole in the ground where there was probably once a mineral outcrop, is the empty limestone pit. There are in this camp as well as in other Mexican mining camps holes of various shapes and sizes, usually oval or elongated, sometimes with little iron and zinc oxide patches on the walls and sometimes with clean limestone. These steeply inclined chimneys are usually nearly or entirely filled with debris, but deep under the debris, at 100 m more or less, there is often a shoot of oxidized ore. The steeply inclined debris-filled hole represents shrinkage due to oxidation and leaching. There are several examples of this type of shrinkage in the Dulces Nombres camp of Nuevo Leon.

Zoning

Copper and iron deposits occur in and around the diorite plug at Concepcion del Oro where the garnetization is most intense. The copper ores contain a little gold. Farther back from the intrusive contact there are a few small gold-silver-lead-zinc bodies, the largest of which are La Perla, La Laja, and Balcon, and also a few narrow gold bearing stringers. Still farther back from the contact a few meager showings of mercury have been observed. The main silver-lead-zinc deposits occurring in the narrow

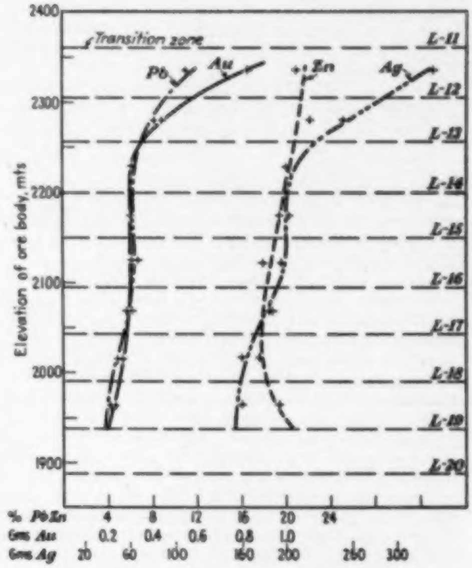


Fig. 8—Avalos unit of zinc west orebody, sulphide assays vs. depth. Cia. Minera Penoles, S. A.

band of Jurassic limestone between a silicious hanging wall and the Providencia monzonite intrusive extend northwestward from the Aranzazu copper shoots for a distance of 5½ km. The alteration to garnet and epidote on the Providencia monzonite contact is not nearly as intense as it is on the Aranzazu diorite contact near the copper deposits.

For several kilometers still farther northwestward along the same sedimentary structure there are occa-

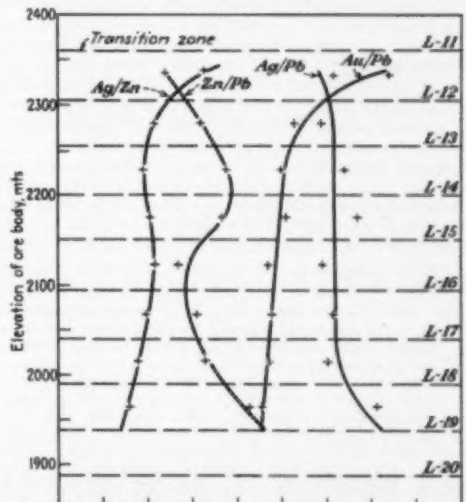


Fig. 9—Avalos unit of zinc west orebody, metal ratios vs. depth. Cia. Minera Penoles, S. A.

sional small showings of silver-lead-zinc antimony-mercury minerals accompanied by an abundance of barite. Some of these have been prospected without commercial success.

No investigations have been undertaken to identify different periods of mineralization, but many observers* have noticed that the oxidized iron in the N. 70° to 80° E. fractures of the Alicante and Refugio mines carry several grams of gold where they cross the base metal ore shoots. The highest assays are found associated with mimetite.

Zoning in depth is an interesting and more practical study, for it differs much from that in some other limestone camps and has a bearing on ore estimation. The transition from oxides to sulphides of the Zinc West body occurs about 500 m below the outcrop at an altitude of approximately 2400 m while that of the Animas bodies is more or less at 175 m below the surface or about 2600 m above sea level.

Immediately below the transition zone, both of these chimneys were almost solid galena, sphalerite, and pyrite. As they were worked downward, patches of limestone showed up in the ore although the total horizontal areas of the chimneys remained almost constant, see Fig. 7. On each succeeding deeper level the proportion of sulphides to limestone diminished. This gradual change is more evident in the Zinc West orebody, for it has been worked 300 m deeper than the Animas bodies. Ore estimates were made by cutting channels across the backs of stopes 1 m apart. Each channel was divided into samples of 1 m lengths. The pay ore showed up in patches, the areas of which were measured with a planimeter, and the proportion of pay ore to limestone was estimated. On the lowest levels the ore amounts to 40 to 50 pct of the total cross-section.

Replacement was not as complete on the lower levels as the upper ones, and the result is that an ore shoot resembles the trunk of a limbless tree with a lot of tenuous rootlets. At Ojuela, Durango, the gradual pinching out of the orebodies is distinctly different. Each chimney or manto has only a single root, which diminishes in size on each succeeding lower level. There, a chimney is like a tree with two or three or more branches and a single tap root, which is more slender on each lower level. For instance, the main Ojuela chimney, which has a horizontal cross-section of 1000 sq m in the oxide zone 500 m below the surface, has only 175 sq m in the sulphide zone at 750 m depth, 85 sq m at 800 m, 40 sq m at 850 m, and 15 sq m at 865 m depth. The ore consisted of almost solid lead, zinc, and iron sulphides all the way to the bottom. There are no data available concerning changes in the grade of Ojuela ore with depth, but no important variations were noted, nor any noticeable increase in the pyrite-galena ratio as at Providencia. Intrusive alaskite that is believed to account for the mineralization was found in diamond drill holes nearly 200 m below the bottom stope, or about 1050 m below the collar of Tiro Norte at Ojuela.

At Providencia, the transition zone consisted of semistratified layers of mud, sand, pieces of limestone, chunks of carbonate ore, and some leached silicious irony material in place overlying semi-oxidized sulphides, which were low in grade. Only a part of the muddy sandy material was minable. There are also evidences of higher transition zones at levels where the water level apparently stood for long periods of time.

Just below the transition zone, the Zinc West sulphides ran comparatively high in precious metals, very likely due to secondary enrichment. Gold, silver, and lead values fall off rapidly in the first 100 m depth. From level 14 downward the decrease is fairly

* John Barry recognized a number of stages but up to this date he has not published his observations.

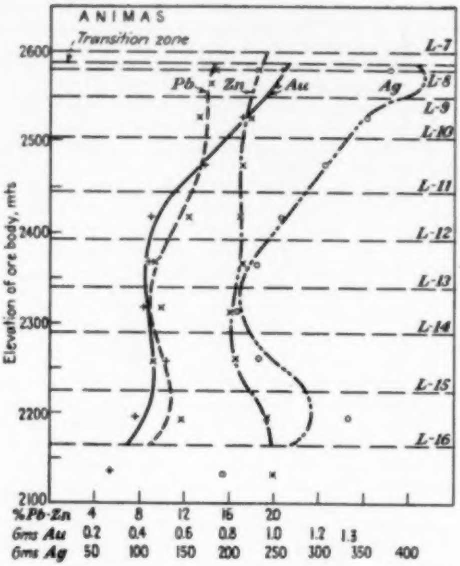


Fig. 10—Avalos unit of Leona and Nazareno orebody, sulphide assays vs. depth. Cia. Minera Penoles, S. A.

Table II. Providencia and Demasias Del Paraiso Mines Zinc West Orebody Assays and Metal Ratios, 1936 to November 1951

Level	Tons	ASSAYS Au, G	Ag, G	Pb, Pct	Zn, Pct	METAL RATIOS Au per Pb	Ag per Pb	Ag per Zn	Zn per Pb
11-12	10,493	0.82	339	11.0	20.8	0.074	30.8	16.3	1.90
12-13	60,496	0.44	240	8.2	22.1	0.053	29.5	10.8	2.69
13-14	91,431	0.31	199	6.2	20.7	0.050	32.0	9.6	3.33
14-15	88,422	0.31	201.5	6.0	19.4	0.051	33.5	10.3	3.23
15-16	80,343	0.31	195.5	6.6	17.9	0.047	29.6	10.9	2.71
16-17	71,903	0.29	185	6.0	18.6	0.048	30.8	9.9	3.10
17-18	41,522	0.25	160	5.3	17.6	0.047	30.1	9.0	3.32
18-19	28,157	0.21	160.1	4.5	19.4	0.046	35.6	8.2	4.31
19-20	3,355	0.23	115	2.3	13.7	0.100	50.0	8.3	5.95
	476,212	0.32	198.8	6.4	19.5				

Table III. Leona and Nazareno Mines Animas Orebodies Assays and Metal Ratios, 1936 to November 1951

Level	Metric Tons	ASSAYS Au, G	Ag, G	Pb, Pct	Zn, Pct	METAL RATIOS Au per Pb	Ag per Pb	Ag per Zn	Zn per Pb
7-8	9,905	1.33	381.1	14.7	18.5	0.090	25.9	20.6	1.26
8-9	39,855	1.11	454.6	14.3	19.5	0.077	31.8	23.3	1.36
9-10	84,080	0.86	355.6	13.3	17.9	0.064	26.7	19.8	1.34
10-11	144,125	0.69	310.5	13.7	17.1	0.050	22.6	18.1	1.24
11-12	109,781	0.45	265.8	12.4	16.9	0.036	21.4	15.7	1.36
12-13	96,744	0.44	210.1	9.4	16.9	0.046	22.3	12.4	1.79
13-14	110,544	0.42	216.3	9.9	16.1	0.042	21.8	13.4	1.62
14-15	152,110	0.52	241.1	9.2	16.5	0.056	26.2	14.6	1.79
15-16	131,430	0.38	330.0	11.8	19.3	0.032	28.7	17.5	1.64
16-17	5,927	0.27	184.3	4.6	19.9	0.058	40.0	9.2	4.32
Totals	884,501	0.56	285.2	11.5	17.4				

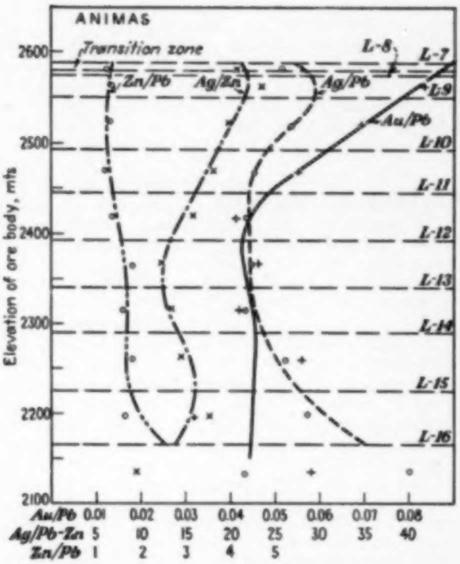


Fig. 11—Avalos unit of Leona and Nazareno orebody, metal ratios vs. depth. Cia. Minera Penoles, S. A.

uniform, see Fig. 8. Zinc assays, although somewhat erratic, fall off gradually throughout the entire vertical range down to level 18 where they take an unexplained turn for the better. Diamond drill holes and uncompleted development on level 20 indicate a sharp decrease in all metals except iron, as shown in Table II. Unfortunately, there are no iron assays available. If there were, observations indicate that the lower levels would show an increase in iron assays and a decided increase in the ratio of iron to the other metals.

Table II and Fig. 9 show the ratios of gold and silver to the base metals, and zinc to lead, plotted against depth. It is interesting to note that the silver-lead ratio increases on the lowest levels as well as the zinc-lead ratio, and the silver-zinc ratio remains nearly constant. A polished surface of sulphide ore from the 14th level of the Providencia mine examined by G. M. Schwartz showed abundant minute inclusions of chalcocite in dark brown sphalerite, but no silver minerals were observed. Supergene chalcocite and covellite were also found. The sulphide ores contain 0.2 to 0.4 pct copper, and possibly some silver may be associated with the copper. No study has been made of this phenomenon, which may possibly account for the behavior of the silver.

In the Leona and Nazareno mines the Animas ore chimneys, which are not oxidized as deeply as the Zinc West, were also comparatively rich in precious metals immediately below the transition zone. This was probably due to secondary enrichment. The gold and silver grades fall off all the way from the transition zone to level 13, a vertical range of 250 m, see Table III and Figs. 10 and 11. Lead behaves in a similar way down to level 12, but the grade drops sharply below level 12 and rises again below the 15th level. The level 12 drop in lead values is more severe than the gradual change in the Zinc West body and no explanation is in sight. The increase in silver and lead below level 15 is accompanied by an abrupt change in the direction of one member of the cluster of steeply inclined chimneys to a flatly inclined manto, which takes off toward the northwest along the axis of a monoclinal fold behind the chimneys shown in Fig. 3. The vertical chimney in the section is low in lead but fair in zinc and high in pyrite, behaving in a way similar to the Zinc West body.

A couple of hundred meters northwest of the main chimney the flatly inclined ore shoot steepens and goes vertically downward in the vicinity of a series of cross fissures as indicated by recent diamond drill holes on level 19. Here the ore is much lower in lead but still high in zinc. Apparently the successive changes in metal ratios from transition zone downward are similar to those in the Zinc West and many other orebodies of this district, although there are variations due to other local influences.

These data, based on substantial tonnages, are included as a matter of record for those interested in the depth changes of replacement mineralization who wish to estimate the depth to which an orebody of commercial grade may extend.

Acknowledgments

The author thanks Charles H. Behre, Jr., and Marden W. Hayward, both of whom are familiar with the Providencia-Concepcion del Oro mining district, for having reviewed and discussed the observations described herein. Edward A. Manderfield, Manager of the Avalos Unit, Paul Pyburn, and Carl Millikan all cooperated in gathering and assembling data. Charles Y. Manderfield, who found new prospects by trenching through caliche, described his newest method of surface prospecting. David B. Dill contributed the general structure of the mountain ranges and made many valuable suggestions. John G. Barry, who has been active in consultation work for the Mazapil Copper Co. and the Cia. Minera Noche Buena, contributed many helpful ideas. Frank F. Grout's and George M. Schwartz' descriptions of the wall rocks and ore minerals were invaluable in interpreting and confirming field data.

The author especially thanks M. C. Haas, General Manager of the Compania Minera de Penoles, S. A., in Monterrey, for his encouragement in writing the paper and his authorization to publish it.

References

[1] C. Burckhardt: Excursion du Nord. Tenth Congrés Geólogique International, Mexico, 1906.

[2] C. Burckhardt: Etude Synthetique sur le Mezozoique Mexican. *Memoires de la Société Paleontologique Suisse*, 49-50, p. 126. Emile Birkhauser et Cie, Basle, 1930.

[3] Ralph W. Imlay: Studies of the Mexican Geosyncline. Geol. Soc. Amer. *Bull.* **49**, p. 1656.

[4] E. H. Sellards, W. S. Adkins, and F. B. Plummer: *The Geology of Texas Stratigraphy*, Bur. Econ. Geol., Univ. Texas (1933) **1**, pp. 270-271.

[5] Lewis B. Kellum: *The Geology and Biology of the San Carlos Mountains, Tamaulipas, Northern Mexico.* Univ. Mich. Press, 1937.

[6] John G. Barry: Unpublished compilation of the work of C. Bruckhardt and R. W. Imlay in relation to sedimentary columns of the Sierra de la Caja and Santa Rosa, Mazapil District, Zacatecas.

[7] Local data compiled by the staff of the Cia. Minera de Penoles, S. A.

[8] D. B. Dill: Compilation from the World Aeronautical Chart 522 and Philip B. King's Geological Map of the Northern Part of Mexico, Plate 1, Cartas Geologicas y Mineras de la República Mexicana (October 1947) No. 3, translation U. S. Geol. Survey publication.

The Surface Expression of Veins in The Pachuca Silver District of Mexico

by C. L. Thornburg

FLANKING the Valley of Mexico on the northeast is a mountain range known as the Sierra de Pachuca. This northwesterly-trending range is about 30 miles long and 5 miles wide, its summit attaining an elevation of more than 10,000 feet above sea level, or 2000 feet above the valley floor. Pachuca, a town of 50,000 inhabitants, lies nestled at the southwest base of the range, 60 miles northeast of Mexico City. Three miles to the east, just over the summit and on the northeasterly slope, is the mountain town of Real del Monte with a population of about 20,000. These are the two principal towns in a 40-sq mile area whose yield has brought the district to its high rank among the world's silver producers. Total production probably exceeds 1.25 billion ounces of silver and 4.5 million ounces of gold.

Exploitation by the Spanish was under way by 1530. As the mines were deepened operations became handicapped by the inadequate method of handling water with horse whims and bull skins. To offset this disadvantage a two-mile drainage tunnel was started in 1749 and completed ten years later. John Taylor of London acquired the mines from the third Count of Regla in 1824 and formed the Compania de Real del Monte y Pachuca. Two years later Cornish pumps were brought from England. A Mexican company purchased the British interest in 1848 and within a few years resumed an old project of driving a second, lower three-mile drainage tunnel, completing it in 1857. After American interests acquired control of the property in 1906 operations expanded to an unprecedented scale, despite periods of political strife, unstable prices, labor problems, and a growing burden of taxation. An idea of the scale of operations may be gained from records of the last two decades prior to 1947, the last year for which production information is at hand, during which time production ranged from 1.4 million to 1.1 million tons per year, and the combined development and exploration, exclusive of diamond drilling, amounted to about 18 miles annually.

Pachuca differs from Zacatecas and some other Mexican silver vein districts that flourished and declined in earlier centuries in that a substantial part of its total production was made after 1900. While the district's accelerated activity in this century was largely due to the successful application of the cyanide process to the treatment of the ores, improved pumping methods, and new mechanical equipment, it was at the same time stimulated by the opening up of important new orebodies as a result of active and extensive exploration of the vein system. Some of these orebodies were found on veins which terminate upward far below the surface, and though these particular veins do not crop out, they show relationship with a type of alteration which may be their surface expression.

The district has been studied by many able geologists, and a large store of information has been accumulated, much of which is recorded in published as well as private papers.

Wall Rocks

Extrusive Rocks: The Sierra de Pachuca is a thick accumulation of Tertiary eruptive rocks consisting mainly of flows, breccias, and tuffs. Numerous recognizable volcanic vents within the range itself manifest that the range was built up by material ejected from these vents. The maximum thickness of the volcanic pile is not known, but from deep exploration and from relationship with Mesozoic sediments to the north and east it is inferred that the average thickness in the main part of the district may be at least 6000 ft. The extrusive rocks comprise four general types, which in ascending order of age are: andesite, rhyolite, dacite, and basalt.

The veins are confined largely to the andesite, the dominant rock of the region. Characteristically this rock is augite andesite, but it includes comparatively acidic as well as basic layers, the acidic strata being

C. L. THORNBURG, Member AIME, was formerly Chief Geologist, Cia. de Real del Monte y Pachuca, and is now Mines Geologist, U. S. Smelting, Refining and Mining Co., Salt Lake City.

Discussion on this paper, TP 3315I, may be sent (2 copies) to AIME before July 31, 1952. Manuscript, Aug. 8, 1951. St. Louis Meeting, February 1951.

classified as interbedded dacites. The andesite is locally overlain by rhyolite, while the still younger dacite occupies a vast area along the crest of the range. Although strong mineralization is confined to the andesite, the rhyolite and at least the lower part of the dacite are of pre-ore age. The basalt is definitely post-ore and is confined to isolated areas, some of which are in lower outlying parts of the range.

Intrusive Rocks: The intrusive rocks consist of dikes and irregular stocklike masses, the various types of which range from rhyolitic to dacitic. With few exceptions the dikes have a northwesterly trend, the direction of early fracturing. In those cases where dikes form one of the vein walls the relationship is structural, the dike contacts being planes of premineral fractures.

Mineralization in Veins: Approximately 70 veins in the main part of the district are characterized by similar outstanding features. The vein pattern consists of three dominant trends: northwest to east-west, north-south, and northeast. In all three systems quartz is the dominant gangue mineral. Calcite, though common, is only locally abundant. Rhodonite, which is typical of the north-south veins, is rare in veins of the other systems, although there are a few exceptions to this rule. A more detailed list would include various additional gangue minerals that are less common. The veins are ordinarily 3 to 5 ft wide; however, stoping is typically 8 to 10 ft wide because of precious metal value in the immediately adjoining wall rock and in parallel stringers. In some veins base metals and silver sulphide are visible in narrow, threadlike, wavy seams conformable to vein attitude, although well-defined vein banding is not the rule. Commonly veins are composed of wall rock breccia in which the fragments are cemented by quartz and silicified and cut by quartz stringers, the degree of replacement by quartz and other gangue minerals varying with intensity of mineralization. Sulphides are typically in subordinate quantity, in blebs, disseminations, and tiny stringers without uniform orientation. Galena, sphalerite, and pyrite are locally prominent, and in some veins base metals are sufficiently abundant to be produced as by-products. The ratio of gold to silver in the ores is about 1 to 200 for most veins.

Oxidation: As a rule complete oxidation does not extend more than 100 ft or so below the surface, except in certain extensively oxidized veins which lie below valley alluvium.

Wall Rock and Surface Alteration in the Productive Area

Chloritization of the andesite is the most widespread type of alteration. It is too general to show definite relationship with individual veins but is a characteristic of productive areas. In a very general way it becomes weaker and more irregular beyond the outer reaches of silver deposition. Although this statement is made with some reservations, it has sufficient basis to explain a tendency to regard areas of unchloritized rock as unfavorable ground for prospecting. Sericitization, kaolinization, and pyritization are much more local than chloritization and are more definitely associated with productive veins. Strong silicification is usually closely limited to the vein zone; as a rule it does not extend more than 5 or 10 ft into the walls. The relationship between silicification and ore is variable because the phases of quartz deposition extended over a wider range spatially and lasted longer than metallization.

A striking feature of much of the surface rock is the extent to which the grayish-green color of the andesite gives way to a buff color caused by weathering of hydrothermally altered andesite. This effect gives the impression of widespread iron stain; in fact, it is due in part to oxidation of more or less pyritized andesite. Whitish to pale buff to yellowish-brown tints all indicate some degree of hydrothermal alteration; and bleached areas, especially where strewn with quartz float, may indicate relationship to ore mineralization. Local areas of such discolored rock in some cases appear to be the only surface expression of veins whose uppermost limits lie far below the surface. Although this surface feature is a characteristic of much of the productive area, its relationship to ore mineralization is uncertain mainly because the range of hydrothermal alteration is vastly more extensive than that of ore deposition. Obviously the weathering of rock to reddish or brownish shades is not necessarily always related to hydrothermal alteration; for example, some darker types of andesite weather to a reddish-brown color apparently caused by oxidation of original rock constituents.

The effect of weathering on hydrothermally altered andesite varies with the extent of erosion. In areas of less rugged terrain where erosion is delayed the altered andesite is marked by weathering that produces an extensive uniformly buff-colored porous shell; whereas in areas of rapid erosion the buff coloring is limited to irregular patches separated by areas of relatively fresh grayish-green andesite.

The common type of pyritization consists of sparsely disseminated minute grains of pyrite in a matrix of greenish andesite. Its range is far greater than that of ore deposition, vertically as well as horizontally. Though of widely varying intensity it is not normally strong for more than a few yards outward from the veins. In some exceptional localities, as in one described later, strong to moderate pyritization extends hundreds of yards outward and upward from the veins.

Expression of Veins at the Surface

In order to provide a general picture of Pachuca veins showing relationship to outcrops, definite surface expression, and less definitely related surface alteration, veins are classified in groups and their locations shown in Fig. 1 by Roman numerals.

Veins Below Valley Alluvium: In Locality I are the Alamo, El Lobo No. 2 and other veins in the vicinity of Pachuca and miscellaneous veins farther east in the Dos Carlos area that lie beneath valley sediments. In Fig. 2 they are shown in section. Prior to their burial beneath wash these veins must have shown strong outcrops.

Veins Below Post-ore Basalt: The Paricutin vein, unique in several respects, is shown in Locality II, Fig. 1, and in section in Fig. 2. In the ores of this gold-bearing vein the approximate ratio of gold to silver is about 1 to 40. Situated in Cubitos Hill at the extreme southern limit of the known district, it lies mainly beneath a blanket of post-ore basalt. The basalt shows no alteration whatsoever. At one isolated spot between the edge of the basalt and the valley alluvium, a small exposure of andesite shows minor barren quartz stringers and weak alteration. While this might conceivably be related to the vein, it can be said that there is nothing anywhere at the surface to indicate an ore-bearing structure. Underground exploration penetrated this locality mainly in accordance with a policy of searching well beyond

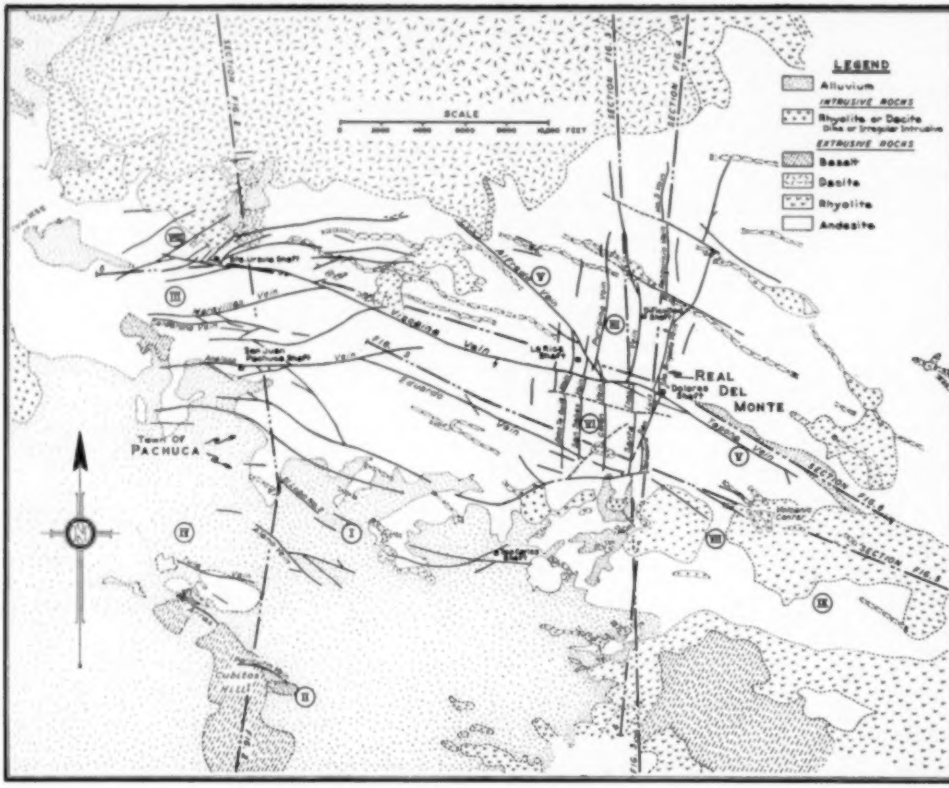


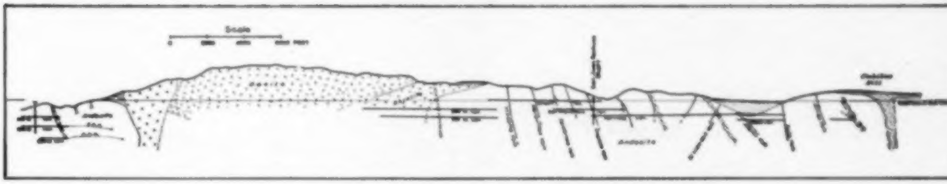
Fig. 1—Generalized geologic plan of main Pachuca district.

the limits of known mineralization. The Paricutin vein is still undergoing development. The productive dimensions as last reported are 1000 ft or so along strike, a width of about 15 ft, and vertical range of 600 ft.

Although this case contributes nothing to the subject of surface expression, it provides useful data pertinent to the study of wall rock alteration. The vein was discovered by a long hole that had to be drilled from an underground base where working conditions were extremely difficult because of excessive heat. As in all venturesome and costly enterprises, the project was attended by periods of discouragement, and after the hole passed from chloritized andesite into rock which showed no alteration, hundreds of feet short of the point where the vein was intersected, a question arose as to the advisability of continuing the drilling. Carefully recorded geological detail showed the unchloritized rock to be a familiar dacitic type which did not show much alteration even in the proximity of a vein; therefore it was not to be considered a discouraging feature which would justify stopping the diamond drill hole. The distinction between these rock types is also alluded to below in description of the Tula vein.

Outcropping Veins Bearing Ore Near the Surface: In the area adjoining the town of Pachuca on the northwest are the Maravillas, Calderona, and Analcos veins shown in Locality III, Fig. 1, and in section in Fig. 2. They are south of the Vizcaina vein in a block of ground which is elevated in relation to the block to the north because of faulting along the Vizcaina, see Locality VIII. Intense erosion of the elevated block has removed the upper extremities of the veins and has left bold outcrops of quartz, gossan, and local ore. Hydrothermal alteration has been moderate and except for rather general chloritization and irregular pyritization does not extend for more than a few yards into the vein walls. North of the Vizcaina there are a number of veins whose upper limits of ore lie hundreds of feet below the surface. There, however, the surface rock is rhyolite, a rock which does not prominently exhibit effects of hydrothermal alteration as does the andesite, and in that vicinity there is practically no surface expression of the underlying veins.

In the Real del Monte area the above structural condition is reversed. Here faulting along the Vizcaina has dropped the south block with respect to the north one, although this faulting does not account for the fact that the tops of the quartz veins in the south block lie so far below the surface, see Figs. 3 and 4. In the north block are numerous vein outcrops, and locally the ore shoots reach the sur-



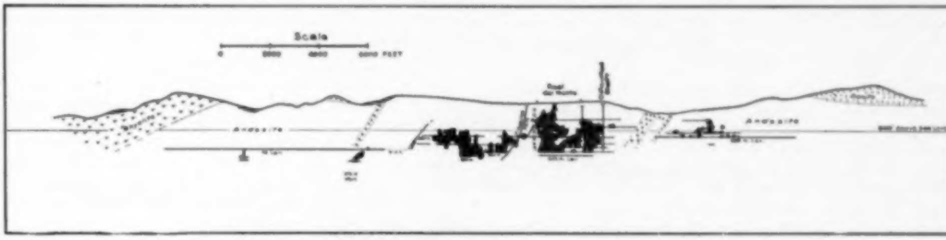


Fig. 2 (Above)—Santa Rosa-Cubitos section, looking east.
Fig. 3 (Below)—Santa Ines section, looking west.

face. Vein outcrops consist of quartz bands ranging in width from a few inches up to several feet, being invariably between hydrothermally altered walls marked by light iron stain. Since their ore shoots are exposed at the surface, these veins were exploited in early times. Drainage of the northeastern slope has eroded this area into strong relief, and the rugged country is dotted with shafts and surface workings along the veins. The zones of hydrothermal alteration are marked in a rough way by large irregular patches of weathered iron-stained andesite. Intervening exposures of less altered rock consist of andesite which is moderately chloritized but otherwise relatively fresh. The adjacent block to the south, as shown in Locality VI, presents some striking contrasts and is described below under *Veins Below Moderate Surface Alteration.*

Outcropping Veins with Ore Shoots Not Reaching the Surface: Some examples of these veins are found in the northern part of Cubitos Hill, north of the blanket of post-ore basalt, see Locality IV in Fig. 1 and the section in Fig. 2. The Tula vein, which is about 7 ft wide, consists of a 3 or 4-ft dominant band of white porous crushed quartz, separated from narrower quartz bands by silicified, partially replaced andesite or dacite. Metallic minerals are not prominent but sparse specks of pyrite, silver sulphide, and native silver may be detected with the hand lens. Locally the wall rock is bleached and pyritized for several feet outward from the vein but is not otherwise notably altered. The proximity of valley alluvium to the projected position of the vein at the surface leaves some doubt as to whether the main structure is really exposed at the surface, but the strip which may represent at least part of the vein consists of a 30-ft band of quartz stringers which vary in width from ¼ in. to 6 in. Minor specks of pyrite are present and limonitic stain is prevalent. Silicification is locally intense, although it does not extend more than a yard or two laterally into surface rock. The only general primary alteration of the wall rock appears to be characteristic chloritization of the andesite; however, within the vertical range of ore a considerable part of the wall rock is a reddish-brown dacitic member of the andesite series that shows little or no chloritic alteration. The top of ore is several hundred feet below the surface and the vertical range of ore is approximately 700 ft. There is no evidence of appreciable removal of silver by leaching, and the top of ore, as in practically all other cases, represents the upper limit of silver deposition in commercial quantities.

Veins Below Strong Surface Alteration: Above the rich and highly productive Tapona vein there is strong surface alteration, shown in Locality V, Fig. 1, and in section in Fig. 6. In this particular locality the characteristic common type of alteration and weathering is outstanding. There is no outcrop of quartz or other normal vein filling, but in a strip of bleached and iron-stained surface some 200 ft long and 50 ft wide there is an unusual accumulation of quartz float, presumably residual, from thin, sparse quartz stringers. Bed rock exposures are too limited to indicate accurately the extent of the band of alteration. A tight northwesterly-striking fracture is discernible in discontinuous exposures. Surface samples of tiny stringers in this obscure fracture zone have assayed as high as 0.5 oz Ag.

Below this area of accumulated quartz fragments the main productive section of the Tapona vein has been mined up to within 300 ft of the surface, and the top of the continuous quartz vein may reach to within 200 ft of the surface. The main productive section extends approximately 1500 ft on strike and 1000 ft vertically. Beyond the main section ore reoccurs far to the southeast in shoots of less extensive vertical range whose tops lie much farther below the surface than the upper limit of ore in the main part of the vein. Above these ore shoots to the southeast surface alteration is comparatively moderate. Here the more intensely altered surface corresponds, therefore, to the section of heaviest ore deposition.

In the range between its upper and lower extremities the Tapona vein typically consists of a 5 or 6-ft zone of quartz bands and ribbons in silicified and otherwise mineralized andesite, the adjoining wall rock being chloritized and locally sericitized. Base sulphides are prominent in the lower productive part of the vein. The upper and middle sections of the vein were locally the source of rich specimens of silver sulphide and wire silver, which could be

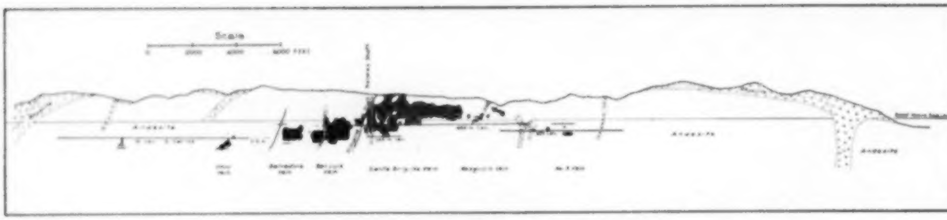


Fig. 4—Section along North-South veins, looking west.

seen in the ore of normal grain only with the aid of a hand lens. The width of ore was highly variable. Normally the stoping width was about 12 ft, but in some places the wall rock was so impregnated with silver that stoping widths reached 100 ft, the orebody consisted of partially-sericitized, chloritized andesite cut by numerous quartz stringers. In these wide sections much of the ore looked like ordinary unmineralized greenish andesite, and stoping limits had to be determined by close assay control.

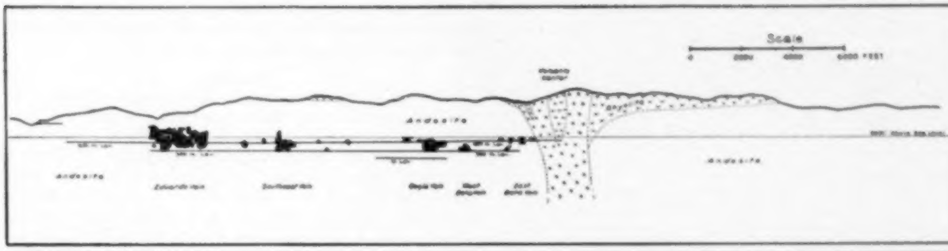
Quartz gangue increases in width to 8 or 10 ft in the lower productive part of the vein, and still deeper, where a diamond drill hole cut the vein 100 ft or so below the general bottom of ore, the width of vein quartz and highly silicified andesite is about 25 ft. Thus from a maximum known depth below commercial values quartz diminishes upward and fails to reach the surface except in the minor degree of tiny discontinuous stringers. It is supposed that below the diamond drill hole intercept the quartz decreases downward as it is known to do in other deeply explored veins.

The Alfredo vein, one of the rich discoveries of more recent times, is a good example of strong surface alteration far above the top of ore. Ore shoots within the productive strike length are spaced along a stretch of 2000 ft. The vertical range of ore is about 1800 ft, the top being about 700 ft below the surface. A quartz-rhodonite gangue is most abundant from the middle to the lower vertical range of ore. The upper limit of the vein consists of minor quartz stringers in a seam of soft, bleached, clay-like substance. Kaolinization is locally intense in the walls of the upper part of the vein. The surface shows a 200-ft zone of iron-stained weathered andesite elongated along the northwesterly course of the vein, though the total extent of surface alteration along strike is indefinite because of accumulations of soil. At the surface the color of this elongated area is a rather uniform buff shade which stands out prominently against less discolored adjacent areas. Within the zone of more pronounced iron stain there are patches of bleached andesite and marked concentrations of quartz float. The only visible quartz outcrop is a lens about 10 ft long and 8 in. wide enclosed in residual hydrothermally altered and weathered andesite. Curiously, this isolated and possibly erratic stringer does not show the northwesterly strike of the vein but has a northerly trend. As in other zones of alteration which overlie veins, it is difficult to find either quartz or altered rock which shows even low silver assays. One familiar with the significance in the Pachuca district of these surface features would probably consider such an area favorable, but he would see little, if anything, on the surface to indicate the position or attitude of the ore-bearing structure. If a prospect shaft were sunk in this area, it would not show iron-stained andesite for more than a few feet below the surface, below which the rock would be moderately kaolinized and chloritized and locally pyritized and sericitized. If a prospector sank on the small quartz lens previously mentioned, he would probably find it too elusive to follow. It would present a discouraging aspect for hundreds of feet below the surface. As a matter of fact, some time before the turn of the century, a prospect shaft was sunk at the west end of the altered zone in the hanging wall of the vein, and at about 300 ft below the surface the shaft cut the vein. At this point the vein consists of 6 or 8 in. of quartz in soft, bleached andesite and shows low silver assays. After a little drifting the work was abandoned at an elevation of some 400 ft above the top of ore. It was not until later that exploration at greater depth reached this part of the district and the Alfredo vein was developed.

Veins Below Moderate Surface Alteration: The foregoing representative cases illustrate that surface alteration is especially conspicuous in areas where the top of the vein is roughly several hundred feet below the surface. It may be added that the closer the top of the vein to the surface, the greater the indication of a mineralized fracture. However, it does not follow that surface alteration is always most prominent in the areas of vein outcrops.

An example of moderate surface alteration above veins is the area immediately south of the town of Real del Monte and south of the Vizcaina vein. It is indicated in Fig. 1 by Locality VI. Some of the veins are shown in section in Figs. 3 and 4. This area has undergone less intensive erosion than that to the north and the terrain is rolling rather than rugged. The remarkable feature of this general locality is that though it is a block of ground of enormous aggregate production from a number of strong veins there are no vein outcrops or exposures of mineralized fractures which might be vein structures. This is the area of the Dios Te Guie, Colon, San Luis, and other notable north-south veins. These north-south veins have quartz-rhodonite gangues with fine metallic bands of silver and associated sulphides. Minute crystals of base sulphides are usually present. As a rule it is only in and near the lower zone of ore deposition that base sulphides become relatively abundant in erratic shoots and segregated masses. Only in the extreme upper zone, very near the top of ore, do the gangue minerals diminish until the veins become one or more narrow quartz stringers usually ½ in. or less in width. These veins show practically no gouge due to movement. Claylike material along the fracture above the ore zone is mainly attributable to the action on wall rock of hydrothermal agencies and the subsequent action of surface waters. Here also are several strong veins of northwesterly strike whose upper limits of ore are far below the surface. In their upper zones these

above, though weaker and less extensive, see *Veins* were shown indicates the locality to be beyond the



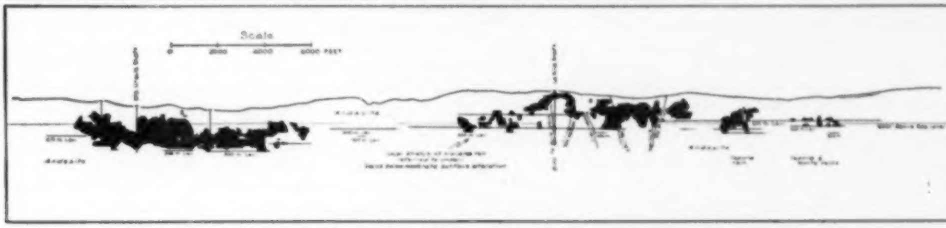


Fig. 5 (Above)—Section along Eduardo vein and veins to southeast, looking northerly.

Fig. 6 (Below)—Vizcaina-Tapona section, looking northerly.

show a more marked predominance of claylike material over quartz than do the north-south veins. The northwesterly-striking veins are marked by more or less post-ore faulting.

The entire area shows lightly iron-stained, slightly bleached andesite, the alteration being so extensive that it can hardly be associated with vein mineralization except in a general way, and yet it is undoubtedly coincident with the extensive, highly productive veins which exist at relatively great depth. Subsurface alteration consists of extensive chloritization and local pyritization. The distance between the top of ore and the surface ranges from 1100 to 1600 ft. Here and there on the surface are patches of small pieces of quartz float, which locally are numerous enough to suggest the presence of one or more quartz stringers. Traceable fractures are nonexistent, although there are some poorly-defined trends of quartz float and belts of relatively strong bleaching which might possibly be the more specific surface expressions of certain deep-seated veins. Prior to development it would have been impossible to make a fair appraisal of such a block of ground. Early property seekers could surmise the prospective value because of its proximity to neighboring productive ground, because of possible extension of known veins into this ground, and finally, perhaps, by comparison of the surface alteration with that above neighboring productive ground to the north. The last would be of doubtful value because of the tendency of this type of alteration to extend well beyond known veins.

The Eduardo vein and a certain productive stretch of the Vizcaina are included in Locality VI and shown in section in Figs. 5 and 6. Neither vein shows an outcrop in this locality, although in neighboring areas the Vizcaina is marked by an easily traceable mineralized structure. Surface alteration is locally strong but in this general area is moderate and widespread, and while it is apparently the result of hydrothermal activity indefinitely associated with ore, there is no specific surface feature to indicate the position of ore-bearing fractures. The alteration is characterized by extensive but irregular bleaching and iron-staining in the andesite, resulting in prominent discoloration with various shades of tan and yellow.

Exploration of the Vizcaina vein in this locality was a matter of driving on it westerly from Real del Monte workings at a convenient elevation well within the vertical range of ore on numerous other veins, this being the 400-m level, which is about 1500 ft below the surface. Ore shoots were found within the interval of strongest surface alteration, a stretch which consists of prominently bleached, iron-stained andesite. Earlier work in a long stretch of this vein farther to the northwest, where the surface shows similar but less intense and less extensive surface alteration, showed only weak metallization.

The Eduardo vein was found as a result of general exploratory cross-cutting combined with diamond drilling. The dimensions of the productive portion of this vein are roughly as follows: The width, as in most veins, is normally 8 to 10 ft. The vein is 2300 ft along strike and 1000 ft in vertical range, and the top of the ore is 400 ft or more below the surface. Quartz deposition was strongest in the middle and lower elevations of ore deposition. Quartz bands and stringers with an aggregate width of several feet persist to hundreds of feet below the bottom of the ore, but this chief gangue mineral eventually diminishes with depth. In the uppermost workings above the top of ore quartz pinches out and the vein diminishes to a thin gouge seam measurable in inches. The andesite wall rock is moderately and uniformly chloritized, and in the upper extremities of the vein it shows some kaolinization. At the buff-colored surface there is an inconspicuous fracture which shows locally minute quartz stringers up to ¼-in. wide. This may represent the vein at the surface, but correlation is doubtful.

Veins Below Weak Surface Alteration: In Locality VII are several comparatively small isolated areas of alteration similar to the large ones described

above, though weaker and less extensive, see *Veins* in section in Fig. 5. In a general way these areas might be correlated as surface expressions of the Regla, Beta, Delta, and Monte veins, whose tops and upper limits of ore are 1000 ft or so below the surface. The altered areas span hundreds of feet, but their irregularity of exposure does not permit description of shape and alignment. The veins of this locality are mainly of northwesterly strike. They do not have the length and vertical range of the great north-south veins of Locality VI, but as a group they have contributed appreciably to the Real del Monte production. Quartz predominates as the gangue only in the lower sections. It gradually decreases from the middle to the upper portion of the productive zone, and there is a corresponding increase upward of soft hydrous minerals including sericite and kaolinite. When production from the middle and upper portions of these veins began to supplant that from the more quartzose north-south veins, the large amounts of these claylike gangue minerals caused a new and permanent settling problem in the cyanide mill. The characteristic wall rock alteration is uniform though moderate sericitization, just as chloritization is common to the wall rock of contiguous productive areas to the north and west. Pyritization is widespread but less extensive than sericitization. These alteration products are the work of agencies which permeated the wall rock for hundreds of yards outward from the veins, and upward beyond the limits of ore deposition.

At its upper productive extremity a typical vein of this area consists of a soft, claylike seam confined to a fracture zone one foot or so in width. It is doubtful that specific surface fractures can be correlated with these veins; however, in the areas of surface alteration there are zones of quartz float which lie close enough to the upward projections of certain veins to suggest relationship. These areas were trenched and sampled for the purpose of obtaining data which might be useful in future exploration. Only discontinuous quartz stringers were found and assays rarely showed more than traces of silver.

Veins Not Below Surface Alteration: Prior comment refers to Locality VIII north of the Vizcaina where veins lie below a large area of rhyolite. This exposure of rhyolite shows no sign nor alteration which suggests that the upper limit of one of the strongest veins of the district is but a few hundred feet below the surface.

Altered Areas Below Which No Veins Were Found: As the foregoing descriptions suggest, surface alteration may be a definite indication of underlying veins in certain cases, while in other cases it may be only a broad and general indication. Reliance on this indefinite guide alone involves the difficulties of determining the location and trend of the ore-bearing fracture. Where alteration is comparatively weak there is the additional problem of ascertaining the extent to which regional alteration outreaches silver deposition. Locality IX is an outlying part of the district where there are a number of isolated areas of altered andesite similar in type but less extensive than those already described under *Veins Below Weak Surface Alteration*. In the search for new veins this locality was explored within an assumed favorable vertical range. Strong fractures were found showing locally abundant pyrite, sericite, and calcite, but with only minor quartz and no silver. That neither silver nor appreciable amounts of quartz were shown indicates the locality to be beyond the limit of metallization, though still within the range of agencies of hydrothermal alteration.

Summary

Of those Pachuca veins whose upper limits lie below the surface, there are some which are obviously associated with strong surface alteration; others, which lie far below large areas of altered surface rock, are not definitely indicated by any discernible surface feature. Where the surface shows intensely altered andesite and conspicuous quartz float several hundred feet above the upper limit of a vein, it may be inferred that this is a definite surface expression; but where surface alteration is moderate and widespread, its relationship with underlying veins is less definitely indicated. The alteration results in a certain amount of bleaching as well as moderate to light iron staining. The areas of alteration may extend hundreds of yards beyond the immediate locality of a productive section of a vein, especially along strike, the lateral extent into wall rock being somewhat less; consequently these altered areas may not give more than an approximate indication of the position of an underlying vein. Moreover, because hydrothermal alteration outreaches district metallization it cannot be assumed that every isolated altered area is underlain at some depth by an economically important vein. But in spite of the uncertainty as to the interpretation of all altered areas, a common relationship between extensively altered surface rock and underlying veins is manifested in some cases.

The study of alteration above the upper limits of ore in the Pachuca district, as in others, is viewed as a progressive one. More detailed work on the identification and associations of significant minerals might provide important contributions to the present knowledge of this subject. A study of representative specimens of altered rock forwarded by A. R. Geyne, geologist for the Cia. de Real del Monte y Pachuca, has corroborated the conclusions of former investigators as to the presence of sericite and kaolinite mentioned in the foregoing descriptions. These specimens also showed montmorillonite and other clay minerals not mentioned in this paper because of the relatively few check samples involved.

Acknowledgment

The writer wishes to acknowledge helpful suggestions and comments by Mr. R. N. Hunt and Mr. C. B. E. Douglas of the U. S. Smelting, Refining and Mining Co., and Dr. P. J. Shenon of the University of Utah. He is obligated also to Mr. A. R. Geyne of the Pachuca staff for constructive suggestions and contribution of miscellaneous data.

References

Ezequiel Ordoñez: The Mining District of Pachuca, Mexico. *Trans.* AIME (1902) **32**, pp. 224-241.

Horace V. Winchell: Geology of Pachuca and El Oro, Mexico. *Trans.* AIME (1921) **66**, pp. 27-41.

Carlton D. Hulin: Geology and Mineralization at Pachuca, Mexico. Abstract in Geol. Soc. Amer. *Bull.* **40** (1929).

Edward Wisser: Formation of the North-South Fractures of the Real del Monte Area. *Trans.* AIME (1937) **126**, pp. 442-486.

E. S. Bastin: Mineral Relationships in the Ores of Pachuca and Real del Monte, Mexico. *Econ. Geol.* (1948) **43**, No. 1, pp. 53-65.

C. L. Thornburg: Some Applications of Structural Geology to Mining in the Pachuca-Real del Monte Area, Pachuca Silver District, Mexico. *Econ. Geol.* (1945) **40**, No. 4, pp. 283-297.

Prospecting the Piceance Creek Basin For Oil Shale

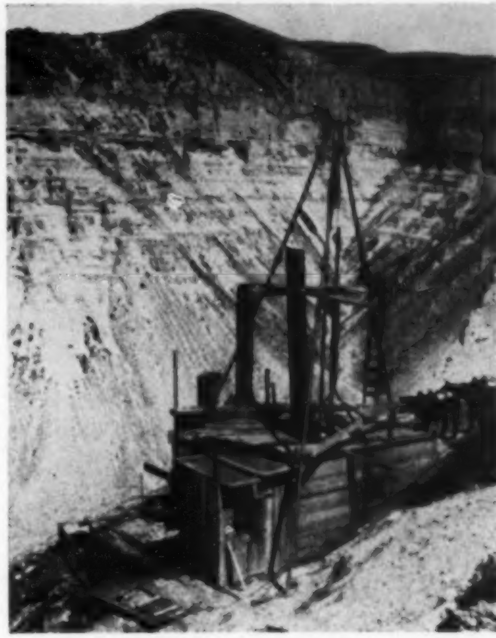


Fig. 1—Oil shale drilling near DeBeque, Colorado, shortly after World War I.

by Tell Ertl

THE Piceance Creek Basin in northwestern Colorado is believed to contain the richest large deposit of oil shale in North America. The major portion, about 1650 sq miles, is bounded by the White River on the north, the Grand Hogback, which runs from Meeker to Rifle, on the east, the Colorado River to the south, and the drainage basin of Salt and Douglas Creeks on the west. The Basin is a plateau 7000 to 9000 ft high, composed of 3000 ft of the Green River series of Eocene age and surrounded by a steep escarpment of 1000 to 3000 ft. From the escarpment the beds dip gently toward the center.

Although oil shale is found in all members of the Green River series, the rich thick beds are found chiefly in the Parachute Creek member. This is normally capped by 100 to 200 ft of the Evacuation Creek, the youngest member of the Green River series.

Actually the Piceance Creek Basin oil shale is not a shale, nor does it contain oil. It is magnesium marlstone holding solid organic matter capable of being broken down by heat into gases, some of which can be condensed into oil. The marlstone is resilient nonporous rock, difficult to sample by pick or hammer and moil.

Many companies and individuals prospected the Colorado oil shale shortly after the first World War,[1] see Fig. 1, but because of the discovery of large quantities of petroleum in the late 1920's in California, Oklahoma, and East Texas, interest in oil shale development waned and did not revive until World War II. In 1944 the writer, employed by the Bureau of Mines, prospected the high grade oil shale in numerous places along the southern outcrop of the Piceance Creek Basin. Several channel samples about 100 ft in length were cut, see Fig. 2. An eight-man crew needed a week to cut a satisfactory channel 80 ft long in the cliff face. The Phillips Petroleum Co., the Union Oil Co. of California and others also prospected the oil shale outcrop. In 1945 the Bureau of Mines initiated a core drilling program for the purpose of obtaining accurate samples from the Piceance Creek Basin. The U. S. Geological Survey set up a program for the geological study of the Basin that is still going on.[2]

Until the end of 1951 a total of 31 holes was drilled for core with diamond drills, and, in addition, cuttings through the oil shale have been obtained from 4 gas wells drilled by standard rotary oil well rigs. The Bureau of Mines drilled 12 of the holes, the Union Oil Company of California 8, the Standard Oil Company of California 6, the Sun Oil Company 3,

TELL ERTL, Chairman, Dept. of Mining and Petroleum Engineering, Ohio State University, is Chairman, Papers and Program Committee, Mining Subdivision, AIME.

Discussion on this paper, TP 3316A, may be sent (2 copies) to AIME before July 31, 1952. Manuscript, Nov. 5, 1951. New York Meeting, February 1952.

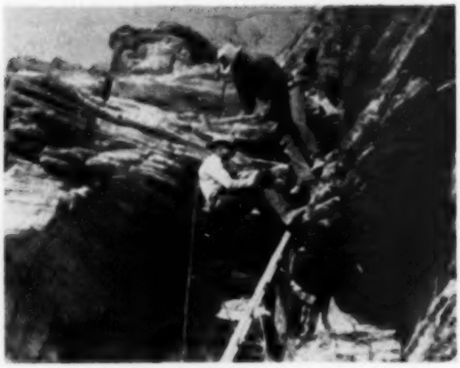


Fig. 2—Channel sampling the oil shale cliff.

and the Pure Oil Company and the Cities Service Company 1 each. Assays of the cores and cuttings delineate an area of 1000 sq miles that can yield 125 billion bbl of shale oil from plus 25-gal-a-ton oil shale, called the mahogany ledge, or 500 billion bbl from the plus 15-gal-a-ton oil shale.[6] The present United States petroleum reserves are estimated to be about 30 billion bbl or about one-quarter the amount that can be obtained from the mahogany ledge of the Piceance Creek Basin.

Core Drilling

The oil shale beds throughout the greater portion of the Piceance Creek Basin dip less than 3°. They are exceptionally uniform in character and thickness. The best method of obtaining samples of the oil shale beds has been found to be by drilling vertical holes for core from the plateau through the rich oil shale. This has been done exclusively by diamond drilling. The first recent oil shale core drilling was done for the Bureau of Mines by the E. J. Longyear Co., which pioneered the techniques used by the other contractors. Among the companies that have drilled for core on the plateau are the Continental Drilling Co., Boyles Brothers, and John Latham.

Because of the semi-arid nature of the Plateau, core holes have been positioned close to the widely-separated streams or springs rather than at locations more desirable for sampling. Nevertheless, a good pattern exists among the holes drilled, although it has been necessary to haul or pipe water long distances to at least six of the holes. At several locations a dam thrown across a dry stream caught enough water for drilling from local thunderstorms that occur in the region during summer afternoons. Snow remains on the plateau until June; therefore access to the sites and drilling cannot start until the beginning of summer. It is foolhardy to attempt to work on the plateau past the latter part of October. Mornings after the middle of September are so cold that water freezes in pipelines and hoses.

At present the following procedure is used in drilling holes on the plateau. A truck trail is built to the site by dozer. The dozer levels off a drillsite and in the more rugged areas, a campsite. The dozer also is used to throw a dam across the local drainage.

Holes 300 to 1100 ft deep are necessary to penetrate through the objective bed, or mahogany ledge, and several have been drilled deeper to explore lower lying oil shale beds. The equipment most often used is comparable to the gasoline engine driven, skid-mounted Longyear UG Straitline or the Joy 22-HD, though lighter machines have been used for some of the shorter holes, see Fig. 3. No portable rigs have been used. Most holes have been drilled 3 in. in diam to yield the 2⅛-in. diam NX core. This large core is desirable because each foot of core provides an adequate sample for assay and permits joint and bedding plane observations. In many holes it has been necessary to case and continue with a smaller hole to yield BX core. In general no additional drilling speed was gained, though core recovery was nearly as satisfactory with BX as with NX. Core recovery through the Parachute Creek formation, which is the chief oil shale member, has been from 95 to 100 pct of the drilled distance when a double tube core barrel was used.

Two holes for dead-men are dug adjacent to the collar site, and logs from local timber are buried about 6 ft deep. To the logs are attached anchor cables to hold the drill firmly in position during the drilling operation. A tripod derrick is erected consisting of built-up timbers, power poles, or locally cut Engelmann Spruce logs. Each leg is 32 ft long and connected on top by a king pin, from which hangs a stationary sheave. A minimum of bracing is used. A ladder or cleats nailed to the main leg is used as a ladderway to the derrick floor, constructed about 16 ft above ground level.

A level base of timber is constructed above the dead-men, and the skid-mounted drill is set on the base and tied down. A hole to firm subsoil or rock is dug and a short, light pipe is placed as a ground casing pipe. A large hole is drilled through the casing pipe and a conductor casing of 3-in. pipe large enough to pass the NX bit is set. This casing is seldom longer than 20 ft and is not cemented. At one site, drilling with the NX bit started on the surface, which was smooth, firm rock.

Fig. 3—Class of drill used in diamond drilling for oil shale.

A stock tank or other type of tank with a capacity of 300 to 1000 gal is used adjacent to the rig as a supply tank. A pump draws water from the tank and pumps it at pressures in excess of 100 psi through the swivel head into the hole. Another pump is set near the reservoir to pump the water to the supply tank. If water is hauled it is dumped directly into the supply tank.

Though oil shale is nonporous it contains intercalated layers of volcanic ash and beds from which gypsum, anhydrite, nahcolite, and perhaps other salts have been leached. These intercalated beds are porous and carry away drill water rapidly. As a consequence few holes have been drilled into the oil shale from which water return has been obtained.

The first recent hole was drilled in 1945, see Fig. 4. Because oil shale recovery conditions were unknown, the drilling contract called for core and sludge recovery. The contractor valiantly tried to obtain water return and sludge recovery and spent a great deal of money cementing the hole and using aquagel, oakum, rope, manure, oatmeal, and other specifics successful in sealing drill holes in other instances. As drilling progressed core recovery increased, and it was agreed with the contractor that if he maintained 95 pct core recovery no sludge would be required. That the contractor kept his part of the bargain is shown by Fig. 5. Cores were so good that the contractors now are permitted to pull 10-ft cores rather than 5-ft cores, and many complete 10-ft cores have been recovered.

Because no water return is obtained no provision is made for it, and larger quantities of water than usual are required for drilling. A rough estimate of water consumption is about 100 gal per ft of drilling. Since drilling rates are about 3 in. per min, water consumption is about 25 gpm of actual drilling.

Constant vigilance must be observed during drilling operations because of the cavities and porous zones that are penetrated. Cavities up to 2 ft in vertical height have been intersected, generally without any difficulty except water loss. However, the rapid water loss has resulted in the burning in and consequent sticking of the bit. The bit and core barrel sometimes become stuck because of the caving of beds above the core barrel. Often when these cavings settle above the core barrel they can not be washed away because water is lost below the top of the barrel. When bits and core barrels become stuck, the use of a 400-lb hammer on the hoist line sometimes sets them free. However, several core barrels have been abandoned in the bottom of holes in the Piceance Creek Basin.

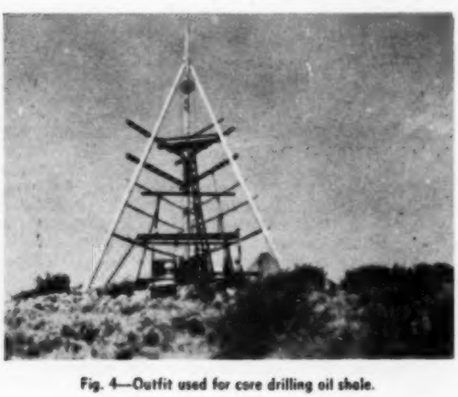


Fig. 4—Outfit used for core drilling oil shale.

Fig. 5—Typical oil shale cores.

An extra large load is imposed upon the tripod when the rods are lowered into or raised out of the hole because no water is in the hole to help support the weight of the rods. A tripod has been known to fail and a string of rods to part because of the load.

Standard core lifter springs are used to catch and hold the core when it is being pulled loose. The core cut from the fine-grained oil shale is so smooth that often the core lifter does not hold the core tightly enough to break it loose. An experienced driller can feel when the core is broken loose, but even the best drillers have had to fish for it after pulling out an empty core barrel. Most often the core remains standing in the hole and the core barrel is easily passed over it for another try at breaking the core free.

In some holes inclined joints are found which cause the cores to wedge in the bit or barrel, and this in turn prevents further penetration of the drill. Oil shale is so strong that no advance can be made by grinding core. An alert driller can feel the core wedge and stop his machine to make a pull. Poor core is recovered when a driller tries to put 10 ft 1 in. of core in a 10 ft barrel. This practice forces the core against the top of the barrel and the pressure shears the entire core in a spiral pattern.

Despite these difficulties contractors seem to want to renew contracts at $6 per ft for drilling. The cost of road and dam construction and hauling water is in addition to the contractor's price.

Logging, Sampling and Assaying

The drilling contractor delivers the recovered core into a trough or core box at the drill site. A representative of the contractee, usually a geologist, stays with the drill crew to oversee the work and to log

the drill cores. Because the holes have been drilled far apart and generally far from the outcrop, careful logging has been necessary to find the objective horizon, the mahogany ledge. The mahogany ledge is that series of oil shale beds that cumulatively assay 25 gal per ton or higher. A persistent 6-in. thick bed of analcitized tuff known as the mahogany marker is found 20 ft below the top of the ledge and 40 to 100 ft above the bottom. This marker is found throughout the Piceance Creek Basin and also in the Uinta Basin in Utah, 100 or more miles from the Piceance Creek Basin. It is a volcanic ash fall, part of which has been altered to well-formed dodecahedral analcite crystals of the size of sand grains. Because of its appearance earlier field geologists called the mahogany marker the sandstone marker or the oolitic limestone bed.[4]

The core from a typical hole is as follows. The hole is collared in the Evacuation Creek member in brown or yellow oxidized sand or siltstone. When the unoxidized Evacuation Creek member is reached it is found to be gray sand and siltstone, in many places containing broken pieces of carbonized vegetable matter. Some marlstone and low grade oil shale beds are found in the member. Marcasite bands are common throughout the section and joint cracks and bedding planes may contain solid bituminous material. The first thick marlstone or oil shale bed is considered to be the top of the Parachute Creek member. This marlstone is gray or olive in color and contains many irregular bands up to 6 in. thick from which gypsum and anhydrite has been leached to leave porous zones of small connected crystal casts. The overall leached zone may be 15 to 20 ft thick. From the leached zone to the bottom of the mahogany ledge the core consists chiefly of oil shale, interbedded with minor amounts of marlstone and shaly marlstone and containing several zones that can be logged over a wide area. A high grade oil shale bed between 4 and 10 ft in thickness frequently is logged 40 to 60 ft below the top of the leached zone. About 100 to 120 ft below the leached zone is found a 10 to 20 ft section of oil shale and marlstone banded with many layers of volcanic ash up to 1 in. in thickness. Partly analcitized volcanic ash bands up to 6 in. in thickness are found in a thin zone about 170 to 200 ft below the leached zone. Another 80 ft down in the hole is found a band of tuff 1 to 4 ft in thickness. The mahogany marker is expected about 100 ft below this thick tuff. The dull white, marcasite-layered marlstone 10 to 12 ft thick that lies directly above the mahogany ledge is a good diagnostic bed. From 10 to 20 ft below the mahogany marker is found the extremely high grade zone of oil shale averaging over 50 gal per ton and recognizable by its appearance and low specific gravity. Below the high grade the tenor of the oil shale gradually decreases, and when low grade oil shale is encountered the hole usually is considered to have reached total depth. Many other less persistent leached zones and volcanic ash zones are found throughout the section.

The cores after they are logged are placed in wooden core boxes made up of four compartments each 2⅛x2⅛x62 in. in size. Each box holds core from at least 20 ft of hole. When full the wooden cover is nailed onto the box. A full box is a good load for one man. The wooden boxes are used chiefly to protect the core throughout the rough truck trip from the drill site to Rifle where the core is split or sawed for sample.

The first cores taken were split in the conventional manner. It was found that oil shale does not split readily into equal halves, and to get accurate samples for assay it was decided to cut the samples longitudinally with a diamond saw. Not only were accurate samples obtained, but the cost of halving the cores was reduced. Furthermore the sawed cores fit neatly into corrugated paper core boxes and can be stored in tall stacks. The half of the core that is not stored is shipped for assay. Sample intervals have coincided with the macroscopic determination of geologic intervals. However, because the change of tenor of the oil shale is gradual, it has been found desirable to take the sample at regular intervals. Most often the sample interval has been 1 ft through the high grade zone, though sample lengths of 2, 4, 5, 10, and 50 ft also have been used. Samples are referred to their distance above or below the top of the mahogany marker.

Samples have been assayed by the Bureau of Mines and the various oil companies. Since 1946, when the Bureau of Mines developed a method of assaying by a modified Fischer retort,[5] all assays have been run in an identical manner. Oil shale assays are indicative only because pilot-plant sized retorts have been operated that yielded as much as 115 pct of Fischer assay.

Assay results of all the drill holes have been made available to the Bureau of Mines and through them to the public. The results have been graphed and compared and a remarkable similarity noted. The U. S. Geological Survey has had access to all the cores and has logged them independently as part of a broad study of the geology of the entire basin.

The present estimates of oil yield from the Piceance Creek Basin, 125 billion bbl from the mahogany ledge and 500 billion bbl from the plus 15-gal-a-ton oil shale, are a result of the prospecting of the Basin done up to the present time. But a sampling of 31 cores from 1000 sq miles of oil shale conveys only a general picture of the reserve. Before any commercial exploitation of the oil shale can begin, each mining area will have to be prospected thoroughly to ascertain the grade and thickness of the oil shale to be mined, the strike and dip of the beds in the immediate mining area, the physical properties of the roof and pillar rocks, and the bedding planes and leached zones which may affect mining practice.

References

[1] R. Burnham: The Oil Shales of Colorado. *California Oil World* (February 1922) **14**, pp. 3, 6, 75.

[2] D. C. Duncan and N. M. Denson: Geology of Naval Oil Shale Reserves 1 and 3, Garfield County, Colorado. U. S. Geol. Survey *Oil and Gas Investigations* (1949) Preliminary Map 94.

[3] Carl Belser: Green River Oil-Shale Reserves of Northwestern Colorado. U. S. Bur. Mines *R. I.* 4769 (February 1951).

[4] Martin J. Garvin and John S. Desmond: Construction and Operation of the Bureau of Mines Experimental Oil-Shale Plant 1925-1927. U. S. Bur. Mines *Bull.* 315, p. 31.

[5] K. E. Stanfield and I. C. Frost: Method of Assaying Oil Shale by a Modified Fischer Retort. U. S. Bur. Mines *R. I.* 4477 (June 1949) revision of *R. I.* 3977.

[6] E. G. Woodruff and D. T. Day: Oil Shales of Northwestern Colorado and Northwestern Utah. U. S. Geol. Survey *Bull.* 581 (1914) pp. 1-21.

[7] Dean E. Winchester: Oil Shale of the Rock Mountain Region. U. S. Geol. Survey *Bull.* 729 (1923) pp. 1-204.

AIME OFFICERS
M. L. Haider, President
Vice Presidents
O. B. J. Fraser J. L. Gillson Philip Kraft
James B. Morrow L. F. Reinartz R. W. Thomas
President-Elect and Treasurer
Andrew Fletcher
AIME STAFF
E. H. Robie, Secretary
Assistant Secretaries: J. B. Alford
H. N. Appleton E. J. Kennedy, Jr.
J. V. Beall E. O. Kirkendall
R. E. O'Brien, 808 Newhouse Bldg., Salt Lake City
Assistant Treasurer: P. J. Apol

aime NEWS

Need Only Two Endorsers For Student Status Change

An appropriate change in Art. I, Sec. 9, of the bylaws was voted by the Board on April 16 whereby, in the case of Student Associates applying for change of status to Junior Member, only two endorsers are needed instead of three, provided one of them is the same member who endorsed his original application for Student Associateship.

Western Secretary Named Field Secretary

R. E. O'Brien's title has been changed from western secretary of the mining branch to field secretary of the AIME, as expressing more accurately his field of activity. His headquarters will remain at Room 808, Newhouse Bldg., Salt Lake City.

The appointment follows the recommendation made by the Mining Branch Council at its February meeting.

Study of Hocott Proposal to Continue

At the April meeting of the AIME Board of Directors, E. E. Schumacher presented a report of the committee of which he was chairman that had been named to study the Hocott proposal. Main points in this proposal are that Local Sections be responsible to, and under the direction of, the Branch Councils rather than be administered by AIME headquarters; and that no more appropriations be made to Local Sections out of the AIME treasury—they would be financed by local dues and assessments. Four recommendations to the Board were made by the Schumacher committee: (1) There shall be no rebate of members' dues to Local Sections except as specified by individual members. (2) That the present Institute structure be continued. (3) That the authority of the Branches to serve the professional and administrative needs of local units be confirmed consistent with general Institute policy. (4) That a permanent Inter-Branch Council be established to study Institute organizational problems. This Council shall consist of (a) the Institute secretary, as permanent chairman; (b) the three Branch chairmen and immediate past chairmen or their designated alternates; and (c) the three Branch secretaries. This Council is to meet prior to the meeting of the Board of Directors at each Annual Meeting of the Institute and at any other necessary times.

The Board, at its April meeting on the 16th, voted to accept recommendations 2, 3, and 4, and to refer recommendation No. 1 to the committee authorized in recommendation No. 4 for future consideration.

Wyoming Geological Assn. To Hold Field Conference

The Wyoming Geological Assn. will hold its 7th annual field conference on Friday, Saturday and Sunday, Aug. 1, 2 and 3, 1952. Thermopolis, Wyo. will be the headquarters for the conference and daily field trips will be conducted in the southeastern portion of the Big Horn Basin, Wyo. Registration will start at 1:00 pm Thursday, July 31.

The Mesaverde, Frontier, Phosphoria and Tensleep formations and outcrops will be studied to learn more about the regional and local changes in these formations. Areas to be visited include the north flank of the Owl Creek Mountains (type section of Embar), the Wind River Canyon (north portion), Mahogany Butte, Tensleep Canyon and the Kirby Creek, Lake Creek, Black Mountain, Manderson and Nowood anticlines. The route of one of the field trips will also carry the caravan past the sulphur plant north of Worland.

AIME Fall Meeting Part Of Centennial Celebration

This year the Fall Meeting of the AIME at Chicago will be part of the celebration commemorating the 100th anniversary of the first national society of engineers—the American Society of Civil Engineers. The tentative program for the Centennial lists some 44 scientific societies that will participate in the ten day festival, September 3 to 13, which will be the world's greatest convocation of engineers. The AIME program will be at Chicago's Palmer House, September 3 to 6.

The AIME plans, to date, include five division programs and two all-Institute functions. The Chicago Section will act as hosts for a dinner and business meeting Friday evening, September 5. On Saturday night the meeting will culminate in a dinner-dance for AIME members, their ladies and guests.

Divisions planning to hold technical sessions will include the Industrial Minerals, Geology Subdivision of MGGD, Iron and Steel, Coal, and Minerals Beneficiation.

Industrial Minerals Div. program has two all-day field trips planned for September 3 and 4 preceding the formal meeting, together with two days of technical sessions. A symposium on Ground Water for Industry will be of great interest to all branches of the engineering profession. This is scheduled for Saturday, September 6. On September 4, after the last field trip, the Industrial Minerals Div. will have an informal smoker for its members and also will sponsor a luncheon and business meeting on Friday.

The Geology Subdivision has outlined its program: September 5 (afternoon) technical session, Brown Iron Ores; September 6 (all day) symposium on reviews of activities of state geological surveys of six of the midwestern states; geology luncheon. During the AIME meeting, the Centennial exposition at the Chicago Museum of Science and Industry will present an integrated, factual exhibit displaying the basic principles behind the development of our industries. This exhibit will be a continuous thing for the next five years.

The 1952 Fall Meeting, together with the centennial stands to be an outstanding one, with great impact in pointing up the significant role the engineering profession has played in the development of the highly industrialized world of today.

Why AIME Members Should Vote for a Continuance of the Present Scale of Dues

By Michael L. Haider, AIME President

Three years ago AIME members were asked to vote on an increase of $5 in the annual dues for Members and Associate Members and of $2 for Junior Members. This increase in Institute income was made necessary by a long series of deficits, that for the year 1948 alone being $82,000. The increase was voted by 78.5 pct of the voting members of each of the Mining and Metals Branches and by 77.4 pct of the members of the Petroleum Branch. The proposal, later expressed in the bylaws, was that the increase should obtain for three years only, 1950, '51 and '52. It was felt that the situation should again be surveyed in 1952. You will therefore now again be called on to vote as to whether or not the present scale of dues shall be continued, as is recommended by the Board of Directors. You will receive a ballot during June if you are a paid-up member living in the United States, Canada or Mexico.

The increase in dues reduced the deficit in 1950 to $15,000, and last year a surplus of $8000 was achieved in spite of continuously rising costs. A surplus of about the same amount is indicated for 1952. Continuing surpluses are needed to replenish our emergency reserves depleted to meet past deficits.

The Institute income is largely derived from two sources: (1) Dues and initiation fees, and (2) advertising and sale of publications. Last year 59 pct of the income was from the first source and 39 pct from the second, leaving 2 pct from miscellaneous sources. In 1949 a new publication policy was adopted whereby we put out three magazines, each in specialized fields, instead of Mining and Metallurgy as previously. The objective of this policy was not only better to serve the members but also to attempt to increase our advertising income. In 1949 advertising income was $86,000, compared with $103,000 in 1950, $144,000 in 1951, and $165,000 (estimated) in 1952.

Your Board has given serious consideration to reductions which might be made in Institute expenses. As a result of such studies, the Institute headquarters staff has been reorganized and equipment is being modernized. It is expected that increased efficiency and maximum operating economy will result. In spite of close scrutiny of costs, 1950 showed an increase of 7 pct over 1949, and 1951 increased 1 pct over 1950. Although the number of members increased each year, the number of regular paid staff employees was exactly the same at the end of 1951 as at the end of 1949.

A detailed analysis of the AIME income and expenses, both as to totals and on a per-member basis, covering the year 1951, appeared in the April issues of the Institute's three journals. Should the dues revert to their former level, it is estimated that income from this source would drop by approximately $69,000, or $3.50 per member including Student Associates. The resulting deficit would present a serious problem indeed as special funds which met the previous deficit have now been all but exhausted and your Board does not feel that drastic reduction in publications or staff are possible without serious impairment of services to members.

Most national engineering societies, and others in the mineral technology field, have been forced to increase their dues to offset inflation in printing and material costs as well as in salaries. In certain instances it has been possible for societies to escape the need for higher dues through having a comparatively large proportion of their income from sources other than dues, such as advertising, equipment shows, and profits on the sale of books.

The price level—the value of the dollar—is so uncertain in its present trend that income and expenses of the Institute are difficult to project into the future. If it should appear safe to do so, your Board of Directors has the power to reduce dues in the years ahead. On the other hand, dues can only be increased by vote of the membership.

You are strongly urged to return the ballot to be sent to North American members in June so that the returns will be as representative as possible of the wishes of the membership. You are also urged to give your Board of Directors a vote of confidence by authorizing them to continue the present scale of dues (Members and Associate Members, $20; Junior Members, $12 for the first six years of such membership, thereafter $17).

Ducktown Basin Holds Meeting for 81 Southeast Section Members

The Ducktown Basin was recently host to the Southeast Section, AIME, with 81 members present representing seven states. The program was presented by the staff of the Tennessee Copper Co. The forenoon technical session, under the chairmanship of H. F. Kendall, superintendent of mines, was opened by a welcome from C. H. McNaughton, production manager. R. R. Burns, assistant manager, gave a general description of the operation and brought out the gradual change from a purely copper industry of the 19th century to the metallurgical and chemical operation of today.

Structural features of orebodies in the Ducktown district was presented by Owen Kingman, geologist, and sinter plant practice was explained by V. L. Hill, general foreman, smelting dept. Section chairman Lamar Weaver, general superintendent, introduced the Section officers. Field trips to mines, flotation, and smelter occupied the afternoon.

The evening session was a joint meeting with the Tennessee Copper Engineers Club. The subject of fungicide manufacture was discussed by M. E. Gray, W. F. Keffer, and R. E. Carver; superintendent, assistant superintendent, and foreman, respectively, of the acid dept.

At the meeting of directors and committee chairmen, J. F. Myers, national director; A. J. Blair, past national director; and E. H. Rose, section delegate, outlined how the Southeast Section can be strengthened. Mrs. Lamar Weaver and Mrs. F. M. Lewis were in charge of the ladies' entertainment.

Credit for arranging this meeting is due Southeast chairman Lamar Weaver, secretary-treasurer V. L. Hill, and the Program Committee composed of H. F. Kendall (Tennessee), W. H. Black (Tennessee), John W. Hager (Alabama), and Nelson Severinghaus (Georgia).

Minnesota Section Forms Guidance Program

The shortage of engineers has led to the formation of a guidance committee by the Minnesota Section, AIME. The committee is sending a representative to all high schools, with over 500 enrollment, in the Twin City area and in the Iron Range communities, to council students on the careers open to them in the mining industry of the state. The committee has six members, with William R. Van Clyke of Cleveland-Cliffs Iron Co. as chairman.

Engineers' Group Organized in Lima, Peru

A monthly luncheon meeting has been organized in Lima, Peru, for members of all international engineering societies. These meetings are held every third Wednesday of the month at 12:30 pm in the Golden Room of the Hotel Bolivar. In case of a holiday, the meeting is held on the fourth Wednesday of the month.

B. A. Bramson (AIME), U. S. minerals attache; E. Portaro (AIME), directing manager of Cia. Minera Atacocha; and C. W. Westphal (AIME), technical representative for the Dorr Co. make up the program committee. A. Arias (AIME), engineer, International Machinery Co., is secretary.

Student Conclave Attracts 128 Delegates to St. Louis

Some 128 students representing five universities attended the two-day student conclave held at Washington University, St. Louis, Mo., April 18. The opportunity for meeting industrial leaders on an informal basis was almost unanimously acclaimed as the outstanding feature of the event. Delegates came from St. Louis University, Missouri School of Mines and Metallurgy, Iowa State College, University of Illinois, and Washington University. L. P. Davidson opened the first day's session, telling how surplus funds from contributions made by various companies to the annual meeting, were used to finance the student conclave.

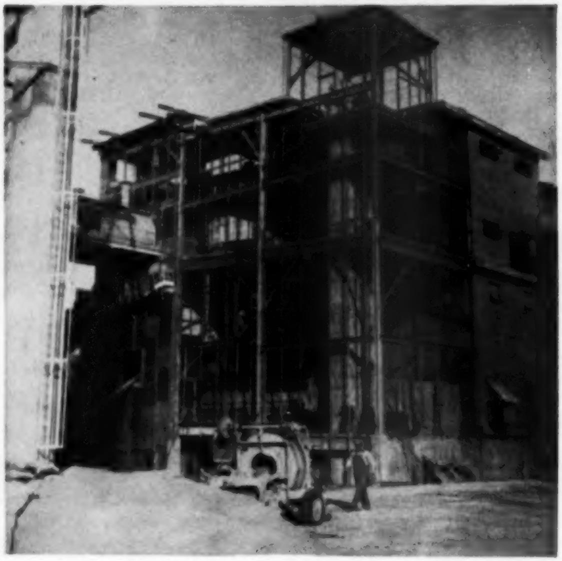
After the initial gathering, all delegates, St. Louis section officers, and faculty members had lunch, followed by four 20 min talks. A welcoming introduction by Dean Curtis L. Wilson, chairman of the St. Louis section started the proceedings. The students heard Dr. Frank C. Whitmore, Jr., of the U. S. Geological Survey speak on *Work in the USGA;* L. P. Davidson, general manager of American Zinc Co., of Illinois, on *What Can or Cannot a Metallurgist Be;* Noel H. Stearn, vice-president of the W. C. McBride Co., on the *Oil Industry,* and Francis Cameron, vice-president of the St. Joseph Lead Co., on *Where a Mining Company Offers an Opportunity and Career.* At the end, students and speakers joined together for informal talks. The opportunity for talking freely with section officers and the representatives of industry continued during dinner.

A car caravan formed by 30 students the next day traveled from St. Louis to Herculaneum. Enroute, students had the opportunity to study the geological formations of the area. Three St. Joseph Lead Co. men guided the students through the smelting plant. The caravan then moved to the Missouri School of Mines and Metallurgy at Rolla, joining those who did not make the trip. Two members of the U. S. Bureau of Mines addressed the students on *Hazards of Static Electricity.* Live demonstrations accompanied the lecture.

Dinner at the Edwin Long Hotel, Rolla, climaxed the conclave with Sparky Stalcup, Missouri University basketball coach, holding forth. Curtis L. Wilson expressed the section's gratitude for the reception given the idea of the conclave by the students. Paul Mudra, president of the St. Louis University Student Chapter expressed the thanks of the delegates.

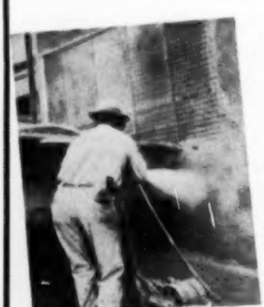
The next Conclave will be held at Rolla in 1953.

110 ADDED BARRELS PER HOUR



Enlarging and modernizing the grinding room of this large cement plant provided a *gain in finished product* which far outweighed the costs involved.

Consult Stearns-Roger as to how to eliminate "bottlenecks" and increase both your plant production and efficiency.



Gunite...one of many modern types of wall construction employed by Stearns-Roger in buildings which house industrial plants.

COMPLETE NEW PLANTS OR ADDITIONS TO EXISTING STRUCTURES

Undivided Responsibility

- ENGINEERING
- MANUFACTURING
- DESIGNING
- CONSTRUCTION

Stearns-Roger

THE STEARNS-ROGER MFG. CO. DENVER COLORADO

Engineers Meet at Golden

Nearly 1500 people attended the Colorado School of Mines 18th annual Engineers' Day celebration April 18 to 19. Sixty-one representatives showed equipment at this year's exhibit, termed the finest ever displayed at the Engineers' Day event.

The two-day session allows Colorado School of Mines students, who will be going into industry this spring or in the coming years, to exchange ideas with industrialists.

Principal speaker at the affair was James Boyd, exploration manager for Kennecott Copper Corp. and former U. S. Bureau of Mines head, who blasted the trend toward centralization in the federal government. Other speakers were: C. E. Ridell, Denver, district geophysicist, Union Oil Co.; George R. Downs, Denver, div. resident geologist, Carter Oil Co.; Milton B. Dobrin, Dallas, senior research technologist, Magnolia Petroleum Co.; S. P. Warren, Lakewood, Colo., consulting engineer; Paul D. Torrey, Austin, president, Oil Recovery Chemicals; Llewellyn Heard, Whiting, Ind., chemist for Stanolind Oil Co.; James D. Forrester, Rolla, Mo., chairman, dept. of mining engineering, Missouri School of Mines; Malcolm P. Grover, Denver, branch manager, Braun & Co.; and Elmer Gammeter, Milwaukee, director of laboratories, Globe Steel Tube Co.

Branch Council Heads Now Ex-Officio Directors

By vote of the Board at its April meeting, the bylaws were changed to make Branch Council Chairmen ex-officio Directors of the Institute. Division Chairmen have for some years been ex-officio Directors. Thus the total number of AIME Directors is now 39, consisting of 27 elected Directors, 10 Divisional Chairmen ex officio, and 2 Branch Chairmen ex officio. (The Petroleum Division Chairman is also the Petroleum Branch Council Chairman.)

No Change In Extractive Metallurgy Publications

At its April meeting, the Board again discussed the long-standing controversial problem of whether extractive metallurgy papers should be published in the JOURNAL OF METALS or MINING ENGINEERING, or both. Some members of the Extractive Metallurgy Div. prefer them to appear in one journal and some in the other. Strictly from the publishing standpoint, considering editorial coverage, circulation, and advertising income, the AIME is much better off to have such papers appear only in the JOURNAL OF METALS.

The Board decided to continue the present practice of publishing in

Mining Engineering only those extractive metallurgy papers so recommended by an auxiliary publications committee of the Mining Branch; to publish also brief abstracts in Mining Engineering of extractive metallurgy papers that appear complete in Journal of Metals; and further to publish as much material in the Journal of Metals that is of interest to extractive metallurgists as is practical. Members receiving either journal may have a subscription to the other for an additional annual payment of $4.

Carolinas Added To Southeast Section

North and South Carolina were added to the territory of the Southeast Section at the meeting of the AIME Board on April 16. These states had not previously been assigned to any Section.

Black Hills Section Is Host to 1952 President

The Black Hills Section, AIME, was host to M. L. Haider, 1952 president, at a luncheon and dinner held on April 25 in Lead, S. D. The dinner meeting was presided over by chairman John W. Mitchell, manager of the consolidated Feldspar Properties, Keystone. Guy N. Bjorge, general manager, Homestake Mining Co., introduced Roy E. O'Brien, field secretary, AIME, and Mr. Haider.

Mr. Haider spoke to the members and guests regarding past and current changes in the AIME, and then addressed the group on *Oil and Gas Development in Canada*.

At luncheon he addressed the Drill and Crucible Club, the student associates at the South Dakota School of Mines and Technology, Rapid City. Mr. Haider emphasized that a professional career should be built on a foundation constructed at school and that upon graduation the career which is just starting will require continuous study. He also pointed out the important factor of scientific development in the interchange of technical and professional knowledge and scientific data.

1952 Budget Approved

The final budget for 1952 was approved by the Board at its April 16 meeting. Income from initiation fees and dues is put at $326,000 ($306,000 in 1951); from publications $221,000 ($205,000 in 1951); other sources $7000 ($11,000 in 1951); total $554,000 ($522,000 last year). Expenses for membership services and field activities are budgeted at $107,000 ($81,000 in 1951); publications $311,000 ($294,000 in 1951); and general and administrative headquarters expense $129,000 ($139,000 last year).

Branchwise the budget was divided as follows: Mining income $265,500, expense $244,500. Metals income $163,400, expense $180,300. Petroleum income $125,100, expense $122,200.

An overall surplus for the year of $7000 is indicated.

Utah Section Holds Successful Dinner-Dance

More than 400 people attended the recent President's dinner-dance held by the Utah Section. Almost every profession associated with the Institute was well represented and President Haider remarked that it seemed more like an Annual Meeting than a sectional affair. Held at the Newhouse Hotel, a cocktail party preceded the dinner. Seated at the speaker's table with President Haider were R. E. O'Brien, field secretary AIME; Local Section officers; members of the Executive Committee; Dan McElhatten, chairman of the Entertainment Committee; and Robert S. Lewis, chairman of the Student Affairs.

President Haider was introduced by W. G. Rouillard, chairman of the Utah Section and spoke briefly on the success in the past in the production of raw materials in a free enterprise economy and suggested that such success might continue if enterprise is permitted to be free. He also explained certain matters concerning AIME operations.

President Haider also made a tour of the Kennecott Copper Co.'s copper pit at Bingham, the mills and refinery at Garfield, and the American Smelting & Refining Co. smelter at Garfield.

Officers of the Utah Section are: W. G. Rouillard, chairman; Clark W. Wilson, vice-chairman; and Harry P. Allen, secretary-treasurer. Carlos Bardwell, C. J. Christensen, H. L. Johnson, and J. C. Landenberger, Jr., are Executive Committee members.

Clay Symposium To Be Published

Authorization has been voted by the AIME Board to publish the papers in the Clay Symposium presented at the St. Louis meeting last year. The manuscripts have been edited and this special volume will be available for distribution later this year.

An invitation from the El Paso Metals Section to hold the Fall Meeting of the Institute in El Paso in October or early November 1953, has been accepted. It is hoped that as many of the Institute's Divisions as possible will plan to participate in the technical program. Attractive field trips and social events, on both sides of the border, will undoubtedly be arranged. The meeting will be timed to coincide with the International Mining Days celebration.

—Coming Events—

June 4-14, Mechanical Handling Exhibition and Convention, Olympia, London.

June 6, AIME, Columbia Section, dinner meeting, Spokane Hotel, Spokane.

June 16-19, ASME, semiannual meeting, Sheraton-Gibson Hotel, Cincinnati.

June 16-20, American Electroplaters Society, Industrial Finishing Exposition, International Amphitheater, Chicago.

June 20-21, AIME, Central Appalachian Section, West Virginia Coal Mining Institute, Pritchard Hotel, Huntington, W. Va.

June 22-24, Alloy Casting Institute, annual meeting, Homestead, Hot Springs, Va.

June 23-27, ASTM, 50th anniversary meeting, Hotel Statler, New York.

June 24-28, Industrial Physics Conference, Royal Technical College, Glasgow, Scotland.

July 1-Sept. 30, Centennial of Engineering, Chicago.

Sept. 3-6, AIME, Industrial Minerals Div., annual fall regional meeting, Chicago.

Sept. 3-6, AIME, fall meeting, Palmer House, Chicago.

Sept. 11-13, American Institute of Chemical Engineers, Palmer House, Chicago, Ill.

Sept. 22-25, American Mining Congress, Metal and Nonmetallic Mining Convention and Exposition, public auditorium, Denver.

Sept. 23-25, Institution of Mining and Metallurgy, symposium on mineral dressing, Royal School of Mines, London.

Sept. 30, AIME, Morenci Sub-section, Longfellow Inn, Morenci, Ariz.

Oct. 3, AIME, National Open Hearth, Southern Ohio Section, Deshler-Wallick Hotel, Columbus, Ohio.

Oct. 10, AIME, Eastern Section, National Open Hearth Steel Committee, Harwich Hotel, Philadelphia.

Oct. 20-23, AIME, Institute of Metals Div., fall meeting with National Metal Congress, Hotel Adelphia, Philadelphia.

Oct. 28, Assn. of Consulting Chemists and Chemical Engineers, Inc., annual symposium, Hotel Belmont Plaza, New York.

Oct. 30-31, AIME, Fuels Conference, Coal Div.; ASME, Fuels Div., Bellevue-Stratford, Philadelphia.

Nov. 4, AIME, Morenci Sub-section, Longfellow Inn, Morenci, Ariz.

Nov. 6-8, New Mexico Mining Assn. and International Mining Days, joint convention, Alvarado Hotel, El Paso.

Nov. 18, AIME, Buffalo Section, National Open Hearth Steel Committee, Hotel Statler, Buffalo.

Nov. 19, American Mining Congress Coal Div. Conference, Wm. Penn Hotel, Pittsburgh.

Dec. 2, American Mining Congress, annual membership meeting, University Club, New York.

Dec. 4-6, AIME, Electric Steel Furnace Conference, Hotel William Penn, Pittsburgh.

Dec. 7-10, American Institute of Chemical Engineers, annual meeting, Hotels Cleveland and Carter, Cleveland.

Dec. 8, AIME, Arizona Section, all-day meeting, Tucson.

Feb. 16-19, 1953, AIME, annual meeting, Statler Hotel, Los Angeles.

Mar. 16-20, National Assn. of Corrosion Engineers, annual conference and exhibition, Hotel Sherman, Chicago.

Apr. 20-22, AIME, National Open Hearth and Blast Furnace, Coke Oven and Raw Materials Conference, Hotel Statler, Buffalo.

THE DRIFT OF THINGS

by Edward H. Robie

EIGHT years ago in this department we had a column on the daiquiri cocktail, which, as we pointed out at that time, was invented by mining engineers. Since then we have said little or nothing about alcoholic drinks, but having set the precedent perhaps we may now pass along a little information about martinis.

We have observed that as an aperitif the martini has become increasingly popular with men, so much so that we always feel a bit peculiar if we order something else. And the call is not for just a martini either; it must be a *dry* martini, and some of our friends are extremely particular on this point. The matter has achieved such importance that *The New York Times* devoted half a page to it a few Sundays back. Several recipes are given which may be useful to some of our members when entertaining visitors from this part of the country:

The standard martini is said to be half gin, half Italian vermouth, two dashes orange bitters, and a pickled onion and twist of lemon peel. This progresses to the *very dry* martini, which calls for five parts gin and one part vermouth with an onion, olive, or lemon peel. Several alternatives are offered for the manufacture of the *very, very dry* martini. One is to pour a little vermouth into the mixing glass and pour it out again before mixing gin and ice. A second way is to put the ice in a sieve, hold it over the sink, and pour a little vermouth over it; then put the ice in the mixing glass. A third is to let the draft from an electric fan blow across an open vermouth bottle toward the mixing glass. Then the ultimate is the *awfully dry* martini, obtained by setting the vermouth bottle next to the mixing glass and turning the bottle slowly so that the label is exposed to the gin for perhaps a second.

The Times notes that Mr. Martini himself personally prefers vermouth and soda.

Be Sure and Vote

We understand that a certain number of AIME members read this department to the exclusion of all else in the journals. We even have fairly definite proof that this statement applies to 0.05 pct of the members. For the benefit of this possibly small but undoubtedly select group, we want to call attention to the statement about the dues referendum that appears on page 670 of this issue.

Now of course this Institute, which has been running along through good times and bad for 81 years, will not go out of existence if the Member dues go back to $15 and the Junior dues to $10. But it seems fairly certain that the Directors will, in fact cannot, take a chance on a deficit next year, so in one way or another you would get less than you get now. So it boils down to what you want. A $20 or a $15 Institute, or even a $10 Institute would be possible if AIME members were willing to forego most of the things that have made the AIME what it is. On the other hand, it is entirely possible that if we did as the ASME recently did, and raised our dues to $25, or as the Engineers Society of Western Pennsylvania did and raised them to $30, we could give our members so much more that they would think the increase a good investment. We do not think it would ever be advisable, though, to raise our initiation fees and dues to the levels of some of the labor unions!

Ian Campbell wonders if we have called attention to the fact that the present $20 dues are really no more than the old $15 dues because they can be deducted from income for tax purposes and most of our members are in the 25 to 30 pct tax category. We explained this in some detail in the Drift for March 1949. But as some of our younger members have pointed out, the argument falls down when the taxpayer takes a flat 10 pct deduction and does not itemize his business expenses and contributions.

Your ballot should reach you before the end of June (it goes only to members in North America) and should be returned right away. Like the politicians, we urge every one to vote. Particularly if they vote right. Three fifths of the members voted in the last referendum. Let's do better this time.

Birthday Greetings

AIME's oldest living member was born on July 3, 1849, so next month will be 103 years old. He is Dr. Edward A. Uehling, of 2360 South 81st St., West Allis 14, Wis. We have a letter from him dated March 21 which says, "The years and weather keep me confined to my room. I extend hearty greetings to all the members of the Institute." We think it would be nice if some of our members responded to this greeting. Dr. Uehling joined the Institute 66 years ago, nine years after he graduated from Stevens Institute. His work was in iron and steel, and 65 years ago he was superintendent of blast furnaces for the Bethlehem Iron Co., at Bethlehem, Pa. He then became furnace manager for the Sloss Iron & Steel Co. at Birmingham, Ala. Later he developed and introduced a pig iron casting machine and a pyrometer. He was one of eleven children and his mother lived to be 99.

Engineers' Beatrice Fairfax

Among our extracurricular duties this year is acting as secretary for the Engineers Council for Professional Development. In this capacity, our attention was recently called to a short piece in the March issue of *Family Circle*, a 5¢ magazine sold at Supermarkets. It was in a department headed "Teen Scene" and it told of the dire need for engineers, and urged those who are good at math and science to give serious thought to preparing for the engineering profession. It wound up by saying that those interested should write to ECPD. Close to 100 inquiries are lying on our desk as we write this.

Most of these require thoughtful and intelligent answers, but some are merely amusing. For instance, a young lady in Gallion, Ala. writes:

"Dear Engineers:

"I'm a teen age Girl. I'm fast losing my friends and wonder what can I do to make him understand. Please Send me Some empermashion. I also quiet my best Friend, the one I really love. What can I do to get him back gain? And I want him for my husband."

And this from McCorkle, W. Va.:

"Dear Engineers

"I am 13 years old and I am in Love with a boy and he is 18 years old and he youst to Like me a lot but he go With another girls But seems he Likes me the Best of all the girls, I Just Don't no how to take him. Would you go with him or not."

Personals

Robert J. Anderson, consulting metallurgist, has been appointed head of the newly established dept. of metallurgy at Southwest Research Institute.

Thomas P. Anderson, mining engineer and geologist, has resigned from the raw materials div., U. S. Atomic Energy Commission as assistant chief, Denver exploration branch. He will enter private practice in Golden, Colo.

Enrique Biel is now general superintendent for the Atok Big Wedge Mining Co., Inc. Bagui, Philippine Islands.

Clyde R. Bellows has accepted a position as assistant chief engineer-geologist with the San Francisco Mines of Mexico, Ltd., Chihuahua.

Antonio Ma. Boquer is now assistant mine superintendent of the Surigao Consolidated Mining Co., Inc., Surigao, Philippine Islands.

William Bellano, superintendent Penowa Coal Co., has been transferred to the Marianna Smokeless Coal Co., Marianna, W. Va., as manager by the parent company.

Robert E. Baarson, recently released from active duty in the Navy, has accepted a position with Armour & Co., flotation section, chemical div., Chicago.

Lester R. Brown, Jr. is now with the San Francisco Mines of Mexico, Ltd., Chihuahua.

John N. Butler is now associated with Nevada Scheelite, Fallon, Nev. He had been with the Western Machinery Co., San Francisco.

E. C. Bitzer has joined the raw materials div., Atomic Energy Commission, Washington, D. C., as metallurgical advisor. He recently resigned as vice-president and general manager of Colorado Iron Works Co.

E. C. BITZER

Clark B. Carpenter, head of the Colorado School of Mines metallurgy dept., recently lectured at the Royal School of Mines, London. Professor Carpenter is planning on surveying England's coal, smelter, and steel industries.

Frank A. Colbert has become assistant chief engineer for Patino Mines & Enterprises Cons., Inc., Llallagua, Bolivia.

Roger Milton Caywood is now geologist with the Day Mines, Inc., Wallace, Idaho. He had previously been with the Atomic Energy Commission at Marysvale, Utah.

W. J. Colegrove has joined the geological div., Alcoa Mining Co., Bauxite, Ark. He had been located at Hillsboro, Ore.

John Robert Clarkson has resigned as mechanical and construction superintendent, Yellow Pine mine, Bradley Mining Co., Stibnite, Idaho. He is now production manager for the Clarkson Co. & Equipment Engineers, San Francisco.

George L. Chedsey has accepted a position with the Marshall Equipment Co., Huntington, W. Va. as sales engineer.

L. Elton Davis has accepted a position with the American Ventilating Hose Co., Amesbury, Mass.

William Lee Davidson has been appointed head of the new office of Industrial Development, AEC, Washington, D. C.

Herbert David Drechsler is now mining engineer with the Anaconda Copper Mining Co., Butte.

Louis Dupret is presently in France as chief, mining and metal dept., French Supply Mission.

N. J. Dunbeck, formerly with Eastern Clay Products, Inc., Jackson, Ohio, is now located in Chicago for the International Minerals & Chemical Corp., industrial minerals div.

David M. Ellington has accepted a position with the Columbia Gas System, Pittsburgh, as storage engineer.

Paul I. Eimon has taken the position of junior geologist with the American Smelting & Refining Co., Tucson.

J. McLaren Forbes is now employed as resident geologist for the Consolidated Coppermines, Kimberly, Nev.

Jack Feucht has been appointed chief engineer of the Cleveland rock drill div., Le Roi Co., Cleveland.

H. S. FOWLER

Hedley S. Fowler has been made general superintendent of Kaiser Aluminum & Chemical Corp., fluorspar works, Fallon, Nev. He was recently transferred from the Kaiser Magnesium Co., Manteca, Calif., where he had been mill superintendent.

Richard V. Gaines is resident manager, Exploration, Inc., Joplin, Mo.

Joseph Barron Gillenwater has accepted the position of maintenance superintendent of mechanical equipment, Standard Lime & Stone Co., Martinsburg, W. Va.

John W. Gabelman has resigned as geologist with the Colorado Fuel & Iron Corp. He accepted a position with the American Smelting & Refining Co., Salt Lake City.

James Hopkins has recently returned to Washington, D. C. after a professional trip to Colombia and French Guiana for the Emergency Procurement Service.

Raymond W. Ingels has joined the Colorado Fuel & Iron Corp., Pueblo. He had been a research laboratory assistant for the Kennecott Copper Corp., Hurley, N. Mex.

George M. Humphrey, president of the M. A. Hanna Co. for 23 years, was elected board chairman and chief executive officer. **Joseph H. Thompson,** vice-president since 1937, was elected president and chief administrative officer. **George H. Love,** president of the Pittsburgh Consolidation Coal Co., was elected vice-chairman of the Hanna board and **R. L. Ireland** a Hanna vice-president, was made chairman of the executive committee.

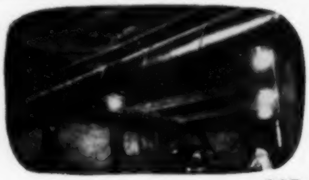
David McRae Irwin is now a sales engineer trainee for the Joy Mfg. Co., Pittsburgh.

Luis Jordan, Jr., Powhatan Mining Co., Bellaire, Ohio has been made assistant chief engineer.

CONSTRUCTIVE SUGGESTIONS

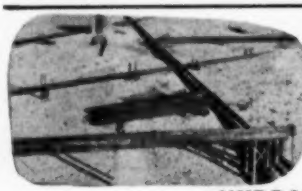
Typical Ways in Which
NAYLOR Light-weight PIPE
Serves Mining Engineers


TAILINGS LINES



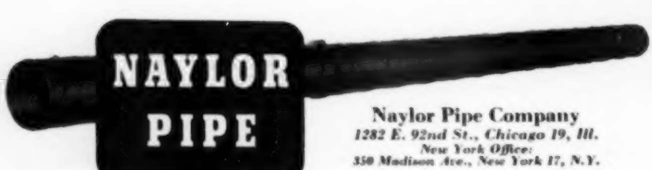

AIR LINES


WATER LINES




HYDRAULIC LINES

Write for Naylor Bulletin No. 507



Naylor Pipe Company
1282 E. 92nd St., Chicago 19, Ill.
New York Office:
350 Madison Ave., New York 17, N.Y.

C. S. Kranick has been appointed sales engineer, Western Machinery Co., Dunmore, Pa.

David L. Kuck has joined the Miami Copper Co., Miami, Ariz., as rodman.

Paul R. Kintzinger is now a geophysicist for the Newmont Exploration Ltd., Jerome, Ariz.

Fred G. Koper is vice-president, Pierce Management, Inc., Scranton, Pa.

Louis Koenig is associate director of the Southwest Research Institute, San Antonio.

Mitchell H. Kline, acting chief, special minerals investigation branch, U. S. Bureau of Mines, has been appointed chief of the rare and precious metals branch. **H. D. Keiser,** formerly a member of the U. S. Geological Survey, has transferred to the U. S. Bureau of Mines as a commodity-industry analyst in the rare and precious metals branch.

George Prentis Lutjet is associate editor, *Engineering and Mining Journal*, New York.

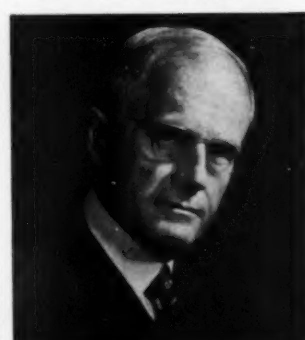
Charles F. Lane, chemical engineer, is a partner in Lane Mfg. Co., East St. Louis.

Solomon Lieb, formerly general superintendent, Bolivian Tin & Tungsten Mines Corp., Huanuni, Bolivia, is now with the Defense Materials Procurement Administration, program development section.

John L. Michaelis has joined Heyl & Patterson, Inc., Pittsburgh, as contracting engineer. He had been chief engineer of the New Martinsville plant, Columbia Southern Chemical Corp.

John S. Marshall is president of Pierce Management, Inc., Scranton, Pa.

Lawrence K. Marshall has joined the Intermountain Chemical Corp., Westvaco mine, Green River, Wyo.



PAUL D. MERICA

Paul D. Merica, executive vice-president and a director, was elected president of the International Nickel Co.

of Canada. **John F. Thompson** continues as chairman of the board of directors and chief officer of the company.

Wilson D. Michell, associated with the Reynolds Jamaica Mines, Ltd., Jamaica, has been transferred to the Reynolds Mining Corp., Little Rock, Ark.

Pedro Horna Moreno has resigned from American Smelting & Refining Co., Trujillo, Peru. He has joined the W. R. Grace Co., Lima, Peru.

D. Morano is now metallurgical engineer with Singmaster & Breyer, New York.

Paul R. Moyer has accepted a position as chief, rock machinery branch, mining machinery div., NPA. He had been mining engineer in the health and safety div., Bureau of Mines.

Walter R. McCormick, Jr. has recently been appointed superintendent of Calera Mining Co.'s cobalt refinery located at Garfield, Utah.

John D. McKichan is now employed by the div. of industrial health, Michigan Dept. of Health, Lansing. He had been ventilation engineer with the Dept. of National Health and Welfare in Ottawa.

Lowell B. Moon is district geologist for the Kennecott Copper Corp., New York.

Thomas H. McClelland is now with Consolidated Purchasing & Designing Inc., San Francisco. He had been located in Colombia for Pato Consolidated Gold Dredging Ltd.

R. F. Mahoney, vice-president Callahan Zinc Lead Co., Inc., San Francisco, is now located in New York.

Roger Neil Miller has accepted a position with the Border Lord Mining Corp., Seattle, as engineer and mill superintendent.

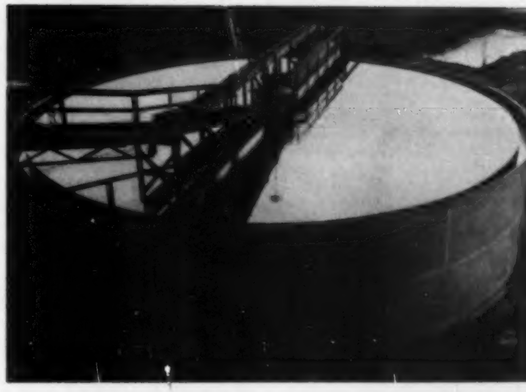
Tikawo Nishiwaki has been transferred to the Kamioka mine as assistant general manager, Kamioka Mining & Smelting Co., Ltd.

Clarence E. Nelson formerly with the Neptune Gold Mining Co., is now general manager for the Buchans Mining Co., Ltd., Buchans, Newfoundland.

Edmund Newton is now designing engineer for the Southwestern Engineering Co., Los Angeles. He had been chief engineer, U. S. Ferro Metals Corp., Deming, N. Mex.

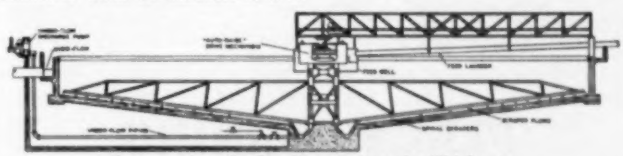
A. S. Narasimhan has accepted the position of geologist in charge of mining and administration, Globe Mining Syndicate, Ramnad, India.

Irving S. Olds, retired as chairman of the board of directors, U. S. Steel Corp. **Benjamin F. Fairless,** president, has been named his successor.



Better Concentration — Less "Down-Time" with HARDINGE THICKENERS

Scraper breakage due to overloads is no longer a problem—at least not with the Hardinge "Auto-Raise" Thickener. An ingenious driving mechanism automatically lifts the entire scraping assembly upward when an overload occurs anywhere in the tank bottom. Another feature of this Thickener is its double-spiral scraper which removes settled solids rapidly—prevents "pile-ups." Available for steel, tile, wooden or concrete tanks up to 200' diameter. Write for Bulletin 31-D-2.



Cross section of a Hardinge center pier Thickener

For
STREAM CLEAN-UP
or
TRADE-WASTE RECOVERY

Hardinge Thickeners and Clarifiers have solved many problems for industries with waste-disposal or by-product recovery difficulties.

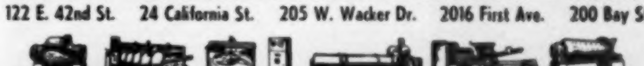
120'-diameter Hardinge Thickener removing 60 tons per hour of solids from coal breaker waste water.

Bulletin 35-C-2

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA—240 Arch St. Main Office and Works

NEW YORK 17 • SAN FRANCISCO 11 • CHICAGO 6 • HIBBING, MINN. • TORONTO 1
122 E. 42nd St. 24 California St. 205 W. Wacker Dr. 2016 First Ave. 200 Bay St.



D. deV. Oxford has been in England and is returning to the Nchanga Consolidated Copper Mines, Ltd., Chingola, Northern Rhodesia.

C. A. O'Connell was promoted from assistant mine superintendent to mine superintendent at Mufulira Copper Mines Ltd., Mufulira, Northern Rhodesia.

W. B. PLANK

W. B. Plank has announced his retirement from the faculty of Lafayette College. He had been head of the mining engineering dept. Prof. Plank joined Lafayette in 1920. He is a past state chairman of the AIME Lehigh Valley Local Section, a member of the ECPD, and served as AIME representative on the Council for ten years and on the Executive Committee for five years.

W. A. Pakkala, Cleveland Cliffs Iron Co., has been named district superintendent, Hibbing, Minn.

W. T. Pettijohn was promoted to superintendent of the Empire Zinc div., New Jersey Zinc Co., Hanover, N. Mex. Prior he held the position of assistant superintendent, Bertha mineral div., Austinville, Va.

Hercules Pappas is now with the Alcoa Mining Co., New York.

J. A. Retty, consulting geologist for the Iron Co. of Canada was the recipient of the Selwyn G. Blaylock medal, Canadian Institute of Mining and Metallurgy. The award was made "for pioneering geological investigations of mineral resources of New Quebec and Labrador."

Paul H. Rumsey is now with the Vacuum Oil Co. of South Africa, Ltd., Portuguese, East Africa.

Arthur W. Ruff is general mine foreman with Cananea Consolidated Copper Co., Cananea, Sonora, Mexico.

John A. Riddle has been made assistant foreman, Phelps Dodge Refining Corp., El Paso. He had previously been associated with the Oliver Iron Mining Co., Duluth.

Frederick J. Ronicker is now associated with the Texas Gulf Sulphur Co., Beaumont, Texas.

Eric J. Rex, Palmer, Mich., is now located at Ciudad Bolivar, Venezuela.

Joseph T. Roe is construction engineer for the Western Precipitation Corp., Los Angeles.

Amos A. Roberts is general sales and service manager of the Baroid Sales Div., National Lead Co., Houston, Texas. He had been at Tulsa.

Walter S. Sims is associated with the Fresnillo Co., Fresnillo, Mexico.

Earl G. Schulz is on leave of absence from Kennecott Copper Corp. and will be temporarily located at Murgal, Turkey as American smelter superintendent.

Charles H. Scheuer has retired from the Minnesota Huron Iron Co. of Ottawa, and the W. S. Moore Co., Duluth.

L. A. Shipman is retiring from active service with the Southern Coal & Coke Co., Knoxville.

Harry A. Strain has retired from the U. S. Steel Co., but is still president of the Fenimore Iron Mines Ltd., Pittsburgh.

Raymond L. Schultze is now employed by the National Lead Co. as mine superintendent, Fredericktown, Mo.

Leonard J. Slessinger has been transferred from superintendent of the San Carlos unit, Cia Minera Nacional, S.A., Chihuahua, Mexico, to superintendent of the Nuestra Senora Unit, American Smelting & Refining Co.

John F. Schnur, foundry superintendent for the McLean Iron Works, Palatka, Fla., has been named foundry technologist at Armour Research Foundation of Illinois Institute of Technology.

Carmelo T. Sison is no longer connected with the Atok-Big Wedge Mining Co., Baguie, Philippine Islands. He has been made geologist for Elizalde & Co., Inc., mining dept., Manila, Philippine Islands.

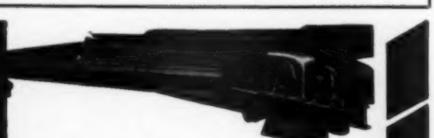
Alvin J. Thompson is head of the dept. of mining and metallurgy, New Mexico Institute of Mining and Technology, Socorro, N. Mex.

R. L. Tobie recently returned from Chile after 22 years with the Andes Copper Mining Co. He is now operating engineer with the Cleveland-Cliffs Iron Co., Ishpeming, Mich.

R. H. Toole is with the U. S. Atomic Energy Commission, Grand Junction, Colo.

Alberto J. Terrones L., Cerro de Pasco Corp., has been promoted from assistant geologist to assistant chief of the exploration dept. at Lima.

PLACER MINING
BUCKET LINE DREDGES
TIN — PLATINUM — GOLD
• SCREEN PLATES • PUMPS
• BUCKET PINS • JIGS
YUBA MANUFACTURING CO.
Room 708 351 California St., San Francisco 4, California, U. S. A.
AGENTS SIME, DARBY & CO., LTD. · SINGAPORE, KUALA LUMPUR, PENANG. SHAW DARBY & CO., LTD., 14 & 19 LEADENHALL ST., LONDON, E. C. 3.
CABLES: YUBAMAN, SAN FRANCISCO · SHAWDARBECO, LONDON

SuperDuty
DIAGONAL DECK
No. 6
CONCENTRATOR
TABLE

Many "Little Things" Add Up to BIG SAVINGS
To the fully obvious advantages of the diagonal deck design, must be added other practical but less evident features if SuperDuty's recognized potential is to be fully understood. Complete balance of all elements effects low operating and upkeep costs, and other benefits all work together for utmost economy. For full details write for the new Bulletin 118B.
THE DEISTER CONCENTRATOR COMPANY
The Original Deister Co., Incorporated 1906
923 Glasgow Ave. Fort Wayne, Ind. U.S.A.

Robert E. Tally, Jr. is assistant manager, Atomic Energy Commission, Colorado Raw Materials, Grand Junction, Colo.

C. T. Ulrich has retired from Kennecott Copper Corp.

John D. Vincent is now with the Northern Peru Mining & Smelting Co., Tacna, Peru.

W. A. Vine is now in the dept. of mining, Missouri School of Mines and Metallurgy, Rolla, Mo. He had formerly been at the School of Mines, Columbia University, New York.

Robert C. Whitehead is with the Broken Hill Proprietary Co., Ltd. New South Wales.

Thomas Walker, Jr. has joined the Hercules Powder Co., Duluth.

B. F. Webster, Jr. has become general manager of the Old Hundred Gold Mining Co., Silverton, Colo.

Cooper H. Wyman recently resigned his position as geologist with the American Agricultural Chemical Co., Pierce, Fla., and is now associated with the exploration dept. of Lone Star Steel Co., Lone Star, Texas.

La Mont West is superintendent of mines and mills for the Pennsylvania Salt Mfg. Co., Marion Ky.

C. W. WRIGHT

Charles Will Wright is presently in Mexico visiting prospects for the Mines Development Co. (Impulsora Minera de Mexico).

J. E. M. Wilson is with the Jeffrey Mfg. Co., Columbus.

Robert L. Wells is affiliated with the Anaconda Copper Mining Co., Reno, Nev.

John W. Warren has been made chief ventilation engineer, Anaconda Copper Mining Co., Butte.

Allen Kelsey Wood, Jr. is now employed by the Humphrey Gold Corp., Starke, Fla.

Edgar E. Wrege, International Minerals & Chemical Corp., Mulberry, Fla. has been promoted to assistant research supervisor. He had been chief chemical engineer.

Raymond E. Whitla was recently transferred from the Bull Shoals Suboffice, Corps of Engineers, Mountain Home, Ark., to the Little Rock District office, Corps of Engineers.

Harry J. Wolf was in California and Colorado during February and April, investigating mineral deposits, more particularly sulphur, mercury, silver, and pitchblende.

Charles E. Yetter returned from mining examinations in India and Indonesia and is now located in Mexico City for the Anahuac Mining & Smelting Corp.

Lewis E. Young, consulting engineer, was recently the recipient of a distinguished alumni award from Pennsylvania State College. **George H. Deike**, president of Mine Safety Appliances Co., Pittsburgh, was also the recipient of a similar award.

Bernard York is associate professor of mining engineering at University of California, Berkeley.

Sergei E. Zelenkov is with the Northern Peru Mining & Smelting Co., Lima.

"ON THE DRILL" BIT SERVICE

with Replaceable Blades Eliminates Bit Dressing . . .

There is no such thing as bit dressing when your test drilling is done with Hawthorne "Blue Demon" bits.

Bit service by Hawthorne comes in sturdy, plainly marked wooden boxes, convenient for handling and storing. Factory controlled high quality accompanies every box.

Your "Blue Demon" Bit assembly is a principal part of your drilling equipment and is used with many sets of interchangeable, replaceable blades. Each set of "Blue Demon" bits is packed individually in a plainly marked cloth bag. Dulled bits are replaceable by a new set of blades, with tools regularly used at the drill, providing "on the drill" bit service at drastically reduced cost.

•

Use "Blue Demon" Rock Cutter Bits, with replaceable blades, in sizes from 1⅞" to 10", for COAL, OIL AND MINERALS EXPLORATION ... TESTING and CORING ... WATER WELLS ... GROUTING ... and FOUNDATION drilling.

Drillers the world over are drilling faster, with fewer bit changes, at reduced drilling costs, with long lasting Hawthorne "Blue Demon" Bits.

Use "Blue Demons" for rock bit efficiency at "fish tail" cost.

Write for Illustrated Catalog

HERB J. HAWTHORNE INC.

P.O. BOX 7366, HOUSTON 8, TEXAS

Obituaries

H. W. Gould (Member 1920) died on Nov. 14, 1951. Mr. Gould was born at Seneca, Mo. on Aug. 18, 1882. For approximately ten years he was engaged in various mining activities in California, Oregon, Arizona, Nevada, and Utah. In 1909 he joined the New Idria Quicksilver Mining Co. in California as mine superintendent. He became superintendent of Harvard Mine, Inc., in 1911, and returned to New Idria in 1916 as general superintendent. Mr. Gould became general superintendent of the Sulphur Bank Assn. in 1917. He was general superintendent and manager of New Idria in 1920 and in 1921 formed the firm of Gould & Meeine, engineers. Mr. Gould had a great deal of experience with mercury and had two U. S. patents on rotary quicksilver furnaces. At the time of his death he was residing in San Francisco.

John C. Green (Member 1944) was killed in an accident during July 1951. Born in 1888 at Galion, Ohio in 1912, he was employed by Westinghouse Electric & Mfg. Co. as a construction engineer at Baltimore and Philadelphia. In 1918 he joined the Kentucky River Power Co. For approximately 25 years Mr. Green was president and general manager of the Mine Service Co., Lothair, Ky.

In Memoriam
John Gross
by G. L. Oldright

About nine in the morning of April 2nd, John Gross passed on to

"The undiscovered country, from
whose bourne
No traveller returns."

even though he be a research man who long has explored and reported his findings. On arising in his home in Santa Monica, Calif., to which he had retired, he had conversed with his wife, Jessie Walker Gross, started to shave—then the end came quickly from a blood clot in the brain.

All who remember John Gross, feel the loss of a keen, analytical mentality governed with a poise and balance, yet a kindliness and humor, that are hard to replace.

In the earlier days of American mining the slogan was, "the white men follow gold." John Gross, after his graduation from the Colorado School of Mines, worked at the Horseshoe mine in the Black Hills of South Dakota, owned by the Maitlands in Denver. He joined the American Institute of Mining Engineers in 1896. He was manager of the Maitland property when the ore "ran out." He went next to Latin America to mine gold in Honduras, returning to be a consultant in Denver. The Bureau of Mines, which was getting started about that time, sent him to lead the work on gold at Fairbanks, Alaska.

After his transfer to the Reno, Nev. station, he worked out, with J. W. Scott as assistant, the fundamentals of the precipitation of precious metals from cyanide solutions upon charcoal. That the gold cyanide radical is precipitated, rather than the metal, lies at the basis of the present rejuvenation of this method of the precipitation of gold as a process with commercial promise.

From Reno he went to the Massachusetts Institute of Technology to plan with a committee of the Institute, including Ernest A. Hersam, Galen H. Clevenger and other well known metallurgists, how to attack a problem that had bothered all metallurgists trying to concentrate valuable minerals aggregated in ores. This problem was, how to measure how much work inescapably had to be done in fine grinding various minerals. Knowing how to measure the work of fine grinding, the metallurgist could "go on from there" to estimate how much of work of fine grinding, usually the most costly step of concentration processes, was useful. The designer

Users praise
ANTON SMIT BITS
in these
volunteered reports:

- They have out-performed the – –and – –bits.
- The heads of Anton Smit bits do not come off!
- An improvement over the other impregnated bit we tried.
- . . . the best bits used thus far on our drilling at – –
- Cut the *highest footage* obtained by any bit on this job!
- Our records indicate a pretty good margin in favor of your bits.
- The first Ascolite bit you sent me worked fine . . . please send me six more . . .
- . . . greatly pleased . . . find them more serviceable than other pre-set bits tried.
- . . . drilled over 500 feet in ground where the average for hand-set bits is 110 feet . . .
- The bits were . . . unusually satisfactory and it is desired to obtain four new bits like them.
- . . . shows a considerable saving . . . over our own cast-set bit . . . we wish to have four more made up.
- *The letters containing the above comments are on file in our New York Office.*

Est. 1908 ANTON Smit & CO., Inc.
Importers and Dealers • Carbons, Bortz, Ballas
Manufacturers of Diamond Tools
333 W. 52nd St., New York 19, N. Y. Cables: PROFITABLE, New York

AIME Student Key

Now available, an attractive gold-plated sterling silver key for AIME Student Associates.

Blue enamel centerpiece with gold lettering, and the name of your school in blue enamel on a gold background.

Actual Size

ONLY $2.75, TAX INCLUDED

Name of school, 8c per letter extra

AIME
29 West 39th St.
New York 18, N. Y.

Please send me ________ Student Associate Keys, for which I enclose check ________ money order ________ for $ ________.

Name of School ________
Name ________
Address ________
City, Zone, State ________

ME6

of new equipment for crushing and grinding would have a yardstick or criterion with which to measure experimentally what he had accomplished. This work on learning the laws of the work of fine grinding was carried out by John Gross and S. R. Zimmerley at the Salt Lake City station of the Bureau of Mines.

John Gross was next transferred to Minneapolis, where among other investigations, he outlined some steps to be carried out by which valuable minerals might be liberated from gangue more selectively by impregnating ores with moisture, which was caused to flash suddenly into steam, thus disrupting the rocks along natural lines of weakness existing at the boundaries of mineral grains. The severe climate of Minneapolis forced his retirement to Santa Monica.

To research men, the life of John Gross is an inspiration on how much a man can accomplish as an individual experimenter, and how lasting the fundamentals of his work can be made, even should he not direct large groups as an executive.

Our deepest sympathies go to those whom he has left behind.

Stuart W. Norton (Member 1936) has died. A graduate of Montana State College in 1928, Mr. Norton was employed by the American Smelting & Refining Co., East Helena, Mont. In 1928 he joined the Anaconda Copper Mining Co. in the research dept. Several years later Mr. Norton went to Chile as research and assistant chief chemist for the Andes Copper Mining Co. In 1933 he did graduate work at the University of Utah. Following this he became metallurgical testing and mill shift foreman for the Itogon Mining Co. in the Philippines. Mr. Norton remained in the Philippines for several years and then returned to the United States. In 1943 he was plant supervisor for the American Cyanamid Co. in Azusa, Calif. In 1946 he was employed in Philadelphia but returned to the west.

Ambrose Ely Ring (Member 1905) died of a heart attack on February 29. Born in New York City, he attended Columbia University and graduated with a degree in mining engineering. He was associated for almost his entire professional career with the mining activities of the American Smelting & Refining Co. Mr. Ring had helped develop and operate many mining properties in Idaho, Montana, Colorado, Utah, and Arizona. In 1949 he retired as manager of the southwestern mining dept., AS&R, Tucson.

Ellsworth H. Shriver (Member 1941) died in Charlottesville, Va. on Aug. 12, 1951. A graduate of Ohio State University in 1914, Mr. Shriver was engaged in coal investigations in Springfield. He was then working as an assistant in the mining engineering dept. at the Ohio State University. He joined the American Star Antimony Co. in 1916. Following his discharge from the Army after the first World War, Mr. Shriver joined the Pike Floyd Coal Co., Kentucky. In 1923 he was made superintendent of construction, coal dept., American Rolling Mill Co., Nellis, W. Va. He later became associated with the Koppers Coal Co. as general superintendent of the Columbia and Beards Fork mines. In 1932 he joined the Raleigh Coal & Coke Co., Raleigh, W. Va. as superintendent. He was made assistant general manager.

Walter W. Stegman (Member 1948) died on July 30, 1951. Mr. Stegman was born in Wheeling, W. Va. on Dec. 14, 1892. For several years he was engaged as a transitman and draftsman. During World War I, he was a master gunner in the U. S. Army. Following his discharge he joined Orion Koller as chief engineer. In 1927 Mr. Stegman opened his office at Wheeling and engaged in civil and mining engineering consulting.

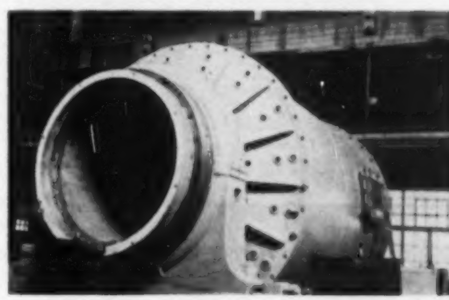
C. C. Van Deventer (Member 1946) was killed in a train accident on May 18, 1951. Born in Mount Morris, N. Y., he attended North Carolina State University and Missouri School of Mines. In 1938, Mr. Van Deventer joined the Republic Mining & Mfg. Co., Bauxite, Ark. For approximately four years he was associated with the Surinam Bauxite Co. in South America. In 1944 he was associated with the Caribbean Petroleum Co., Maracaibo, Venezuela.

the "low down" on grinding

The Marcy low-pulp-line, rapid-circulation-of-mill-content principle of grinding, thru the use of a grate discharge, was first used 38 years ago.

Its wide acceptance has been proved by the universal use of Marcy Grate Discharge Mills and the many repeat orders received based on output and low-cost-per-ton performance.

For example: **LARGE IRON PRODUCER SELECTS 10' MARCY S FOR TACONITE PILOT PLANT**



1 of the 6—10' dia. Marcy Mills being manufactured for a large iron producer in Minnesota. This taconite pilot plant will use 3—10' x 14' Marcy Special Grate Discharge Ball Mills and 3—10' x 12' Marcy Open End Rod Mills.

Other MASSCO products: Massco-Fahrenwald Flotation Machines, Genuine Wilfley Tables, Massco-McCarthy Hot Millers, Rock Bit Grinders, Density Controllers, Belt Feeders, Rubber Pinch Valves, Assay and Laboratory Supplies and Equipment, Complete Milling Plants.

The Mine & Smelter Supply Co.

BOX 5270, TERMINAL ANNEX, DENVER, COLO., U.S.A.
OFFICES IN SALT LAKE CITY, EL PASO, 1775 BROADWAY, N. Y. C.

REPRESENTATIVES: CANADIAN VICKERS, LTD., MONTREAL, CAN., W. R. JUDSON, SANTIAGO, CHILE, THE EDWARD J. NELL CO., MANILA, P.I., THE AUSTRAL OTIS ENG. CO., LTD., SO. MELBOURNE, AUSTR., MORGARDSHAMMARS MEK. VERKSTADS AKTIEBOLAG, MORGARDSHAMMAR, SWEDEN, THE ORE & CHEMICAL CORPORATION, 80 BROAD STREET, NEW YORK CITY 4, NEW YORK, REPRESENTATIVES FOR CONTINENTAL EUROPE

NECROLOGY

Date Elected	Name	Date of Death
1905	Frank F. Colcord	Mar. 21, 1952
1935	E. A. Collins	Feb. 6, 1952
1939	Charles H. Davis	June 1951
1951	Billy F. Edwards	Aug. 6, 1951
1939	William McK. Green	Mar. 13, 1952
1896	John Gross	Apr. 2, 1952
1951	Thomas M. Harris	Unknown
1944	George H. Jones	Unknown
1939	H. M. Lavender	Mar. 21, 1952
1928	Charles Ellison MacQuigg	Apr. 24, 1952
1897	Eugene L. Messler	Unknown
1916	Ross B. Rathbun	Apr. 3, 1952
1896	A. H. P. Wynne	Unknown

Proposed for Membership

MINING BRANCH, AIME

Total AIME membership on Feb. 29, 1952 was 17,221; in addition 2,341 Student Associates were enrolled.

ADMISSIONS COMMITTEE

T. D. Jones, Chairman; Thomas G. Moore, Vice-Chairman; H. S. Bell, F. W. Hanson, R. H. Chadwick, T. W. Nelson, C. A. R. Lambly, John T. Sherman, A. C. Brinker, G. P. Lutjen, Ivan Given, E. A. Prentis, C. Leslie Rice, Jr., and J. H. Scaff.

The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

In the following list C/S means change of status; R, reinstatement; M, Member; J, Junior Member; A, Associate Member; S, Student Associate.

Alabama
Bessemer—Bains, Herman H. (J)
Birmingham—Mitchell, Charles C. (A)
Tuscaloosa—Engel, Niels N. (M) (R, M)

Arizona
Dragoon—Sierakoski, Joseph O. (J) (R, C/S—S-J)
Ray—Keating, Paul (J) (R, C/S—S-J)

California
North Hollywood—Thomas, Blakemore E. (M) (R, C/S—A-M)
Sacramento—Montgomery, Edwin H. (J) (C/S—S-J)
San Francisco—Gabriel, Harry A. (A)
San Francisco—Mein, Gardner W. (M)
San Francisco—Moon, John E., Jr. (J) (R, C/S—S-J)
San Francisco—O'Connell, Edwin J. (J)

Colorado
Climax—Eisenach, Edwin J. (M) (R, C/S—A-M)
Climax—Julin, Douglas E. (J) (R, C/S—S-J)
Denver—Huff, Lyman C. (M)
Grand Junction—Marshall, Milton H. (J) (R, C/S—S-J)

Florida
Bartow—Ensign, Chester O., Jr. (J)
Bartow—Wheless, Robert H. (J) (R, C/S—S-J)

Georgia
Macon—Burns, Henry K., Jr. (M)

Idaho
Kellogg—Muhs, Robert A. (J) (C/S—S-J)
Kellogg—Myers, Wayne L. (J)
Kellogg—Nash, Albert M. (M)

Kansas
Pittsburg—Holmes, Colin W. H. (M)

Massachusetts
Lexington—Carpenter, Fontinelle S. (M)
Williamstown—Martin, Keith (J)

Missouri
Fredericktown—Schultze, Raymond L. (M) (C/S—A-M)

Montana
Butte—Geary, Daniel (M) (C/S—J-M)
Butte—Goddard, Charles C. III (J)
Butte—McLean, William H. (J) (R, C/S—S-J)
Butte—Reed, William M. (J)

Appraisals
Assayers
Chemists
Construction
Consulting
Designing

Professional Services

Space limited to AIME members or to companies that have at least one member on their staffs. One inch, $40 per year; half inch, $25 payable in advance.

RALPH ADAIR
Ore Dressing Consultant
Bull Mtn. Rd., Asheville, N. C.
Phone 4-1693

JAMES A. BARR
Consulting Engineer
Mt. Pleasant, Tennessee
Washington, D.C.

BEHRE DOLBEAR & COMPANY
Consulting Mining Engineers and Geologists
11 Broadway New York 4, N. Y.

I. B. BERENT
Engineering Consultants and Contractors
Mineral Exploration, Mine Evaluation, Mine Designs and Mine Management
156, Ataturk Bulvari—Ankara, Turkey

BLANDFORD C. BURGESS
Registered Professional Engineer
Mining Consultant
Monticello, Georgia

GLENVILLE A. COLLINS
Mining Engineer
Uranium examinations Cable "Colns"
210 La Arcada Bldg. Santa Barbara, Calif.

COWIN & CO.
Mining Engineers and Contractors
Consulting Shaft & Slope Sinking
Appraisal Mine Development
Reports Mine Plant Construction
1-18th St. S. W. B'ham, Ala., Phone 56-5566

MILTON H. FIES
Consulting Engineer
Rooms 1201-2, Alabama Power Co. Bldg.
Birmingham, Alabama

J. FRANK GEARY and ASSOCIATES
Engineers
Metallurgical Plant Design Specialists
11430 Clover Ave. Los Angeles 34, Calif.
Phone EXbrook 7-7635

GEORGE A. HOCH
Thin Section Technician
Standard and Oriented Sections
Unconsolidated Materials a Specialty
Dept. of Geology
Franklin & Marshall College, Lancaster, Pa.

CARLTON D. HULIN
Mining Geology
26th Floor San Francisco 4
Shell Building California

JOHNSTON & POWELSON
Geologists — Reg'd Prof. Engrs.
Examinations — Appraisals
Supervision
44 King St. West—Toronto, Canada

C. P. KEEGEL
Mining and Metallurgical Engineer
Administration Appraisal
Specializing in Management and Consultation in Latin America
707 South 6th Street, Las Vegas, Nevada
Telephone 571

THOMAS L. KESLER
Exploration Geologist
Cartersville, Georgia

KELLOGG KREBS
Mineral Dressing Consultant
564 Market St., San Francisco 4, Calif.

LEDOUX & CO. INC.
Assayers Chemists
Shippers representatives at all seaports and refineries in the United States
155 Sixth Ave. New York

JOSEPH T. MATSON
CONSULTING MINING ENGINEER
Examinations—Appraisals
Operations
P. O. Box 170 Santa Fe, New Mexico

CLAYTON T. McNEIL, E. M.
Consulting Mining Engineer
822 Bank of America Bldg.
Tel. GArfield 1-2948
SAN FRANCISCO 4, CALIFORNIA

ARNOLD H. MILLER
Consulting Engineer
Mine, Mill and Industrial Investigations
Improvement Design and Recommendations
Cable: "ALMIL" Tel. Cortlandt 7-0635
120 Broadway New York 5, N.Y.

RODGERS PEALE
Consulting Mining Geologist
315 Montgomery St.
San Francisco 4, Calif.

LUCIUS PITKIN, INC.
Mineralogists
Assayers—Chemists—Spectroscopists
Shippers' Representatives
PITKIN BLDG., 47 FULTON ST., NEW YORK
Cable Address: Niktip

MILNOR ROBERTS *Consulting Mining Engineer*
The Pacific Northwest,
British Columbia and Alaska
4501 15th Ave., N.E. Seattle, Wash.

PAUL F. SCHOLLA
Consulting Mining Engineering
Metal & Industrial Mineral Mining
Examination, Management, Development,
Surface Plants, Foreign and Domestic
1025 Conn. Ave., N.W., Wash'n 6, D.C.

CLOYD M. SMITH *Mining Engineer*
Washington Representation
Mine Valuations Ventilation Surveys
Munsey Building Washington 4, D. C.

TEKERA INC.
International & National Consultants
Development, technical, operating, management and business problems of the coal, metal and non-metallic mining industries.
274 Madison Avenue New York City 16

SEWELL THOMAS
Consulting Mining Engineer
Plant Layout, Design, Detailing,
Mechanization, Mining Methods
2101 East 4th Denver 6, Colo.

WALKER & WHYTE, INC.
Assayers, Chemists
Shippers' Representatives
409 Pearl St. (Corner New Chambers)
New York — U.S.A.

O. W. WALVOORD CO.
Mill-Design and Construction
401 High St. Denver 3, Colo.

CLIFFORD R. WILFLEY
Consulting Mining Engineer
2233 Grape St. Denver 7, Colorado

HARRY J. WOLF
Mining and Consulting Engineer
Examinations—Valuations—Management
420 Madison Ave., New York 17, N. Y.
Cable: MINEWOLF Tel.: Plaza 9-1700

Drilling
Geophysicists
Management
Metallurgical
Reports
Valuations

ALFORD, MORROW & ASSOCIATES
CONSULTING ENGINEERS
Coal Mining and Preparation
Property Valuations
Prospecting, Development, Mapping
Oliver Building Pittsburgh 22, Pa.

ALLEN & GARCIA COMPANY
40 Years' Service to the Coal and Salt Industries as Consultants, Constructing Engineers and Managers
Authoritative Reports and Appraisals
332 S. MICHIGAN AVE., CHICAGO
120 WALL ST., NEW YORK CITY
66 GLOUCESTER PL., LONDON W.1.

B. B. R. DRILLING CO.
National Road West
St. Clairsville, Ohio
Diamond Core Drilling Contractors
Mineral Cores Guaranteed — Foundation Testing

EAVENSON & AUCHMUTY
MINING ENGINEERS
Mine Operation Consultants
Coal Property Valuations
2720 Koppers Bldg. Pittsburgh 19, Pa.

T. W. GUY
Consulting Engineer
Coal Preparation
To Yield Maximum Net Return
Face and Product Studies
Plant Design and Operation
Kanawha V. Bldg. Charleston, W. Va.

HOLMES & NARVER, INC.
Engineers • Constructors
828 South Figueroa St.
Los Angeles 17, Calif. Trinity 8201

ABBOT A. HANKS, Inc.
ASSAYERS-CHEMISTS
Shippers Representatives
624 Sacramento Street
SAN FRANCISCO

DIAMOND CORE DRILLING BY CONTRACT
and world's largest manufacturer
Core and grout hole drilling in coal, metal, and non-metallic deposits, both surface and underground.
JOY MANUFACTURING CO.
Contract Core Drill Division
Michigan City, Indiana

E. J. LONGYEAR COMPANY
Foshay Tower Minneapolis, Minn.
Consulting Mining Engineers and Geologists
Mineral Exploration — Mine Valuation

R. S. MC CLINTOCK DIAMOND DRILL CO.
Spokane, Wash. — Globe, Ariz.
Diamond Core Drill Contractors
Manufacturer of Diamond Bits and Drilling Accessories

JOHN F. MEISSNER ENGINEERS, INC.
Consulting Engineers
Conveyor Systems — Storage Methods
Crushing Plants — Ship Loading Docks
Materials Handling and Processing Plants
308 W. Washington St. Chicago 6, Ill.

DIAMOND CORE DRILLING CONTRACTORS
Testing Mineral Deposits
Foundation Borings
MOTT CORE DRILLING CO.
Huntington, W. Va.

PENNSYLVANIA DRILLING COMPANY
PITTSBURGH 20, PA.
DRILLING CONTRACTORS and MANUFACTURERS
We prospect coal and mineral land anywhere in North and South America.
Core borings for foundation testing; dams, bridges, buildings, etc.

PIERCE MANAGEMENT, INC.
MINING ENGINEERS
A Background of 22 Years of Design, Consulting, and Management Service to Coal and Mineral Industries in 28 States and 10 Foreign Countries.
Scranton Electric Bldg. Scranton 3, Pa.
1025 Connecticut Ave., N.W.
Washington 6, D. C.

ROGER V. PIERCE
Mining Engineer Specialist
Underground Mining Methods, Cost Cutting Surveys—Production Analysis—Mine Mechanization—Mine Management.
808 Newhouse Bldg. Phone 33973
Salt Lake City 4, Utah

SENIOR, JUENGLING AND KNALL
Engineers & Consultants
Coal Preparation & Mineral Dressing
2100 Seventh Ave., South
Birmingham, Ala.

The Original
ALLEN GROU-TROL PROCESS
Division
WELL SERVICE INC.
Dick Allen, General Manager
19th Fl., Kanawha Valley Bldg.
Charleston 1 West Virginia

SPRAGUE & HENWOOD, Inc.
SCRANTON 2, PA.
Diamond Drill Contractors and Manufacturers
Core borings for testing mineral deposits in any part of the world.

CARL G. STIFEL REALTY CO.
For Industrial Plants, or Plant Sites, of any size . . . anywhere in the United States or Canada, write, phone or wire
CARL G. STIFEL
224 N. 4th St. St. Louis, Mo.
Central 4810

UNDERPINNING & FOUNDATION COMPANY, INC.
155 EAST 44TH STREET
NEW YORK 17, N. Y.
Specialists in Design and Construction of Shafts and Tunnels

G. A. VISSAC
Consulting Engineer
COAL DRYING
Vancouver Block Vancouver, B.C.

JOEL H. WATKINS
Mining Geologist
INDUSTRIAL MINERALS
CHARLOTTE C. H. VIRGINIA

PAUL WEIR COMPANY
Mining Engineers and Geologists
Consultants and Managers
20 North Wacker Drive
Chicago 6, Illinois

WEISS GEOPHYSICAL CORPORATION
Mining geophysical surveys with aerial and ground magnetic, gravimetric, seismic and electrical methods; research and development. Experienced crews for systematic work in any part of the world.
149 Broadway REctor 2-0294
New York 6, N. Y. Cable: "Geophysics"

J. W. WOOMER & ASSOCIATES
Consulting Mining Engineers
Modern Mining Systems and Designs
Foreign and Domestic Mining Reports
Union Trust Bldg., Pittsburgh, Pa.
National Bank Bldg., Wheeling, W. Va.

L. E. YOUNG
Consulting Engineer
Mine Mechanization — Mine Management
Oliver Building Pittsburgh, Pa.

Nevada
Ruth—Meltzahn, Donald W. (J) (R C/S—S-J)

New Mexico
Grants—Terry, Dale O. (J)
Silver City—Harlan, Jack M. (M)

New York
Garden City—Kaiser, Marvin M. (M)
New York—Lesser, Marvin (J)
New York—Model, Wolfe F. (J)
New York—Ramstead, Karl N. (J)
New York—Strouth, Howard S. (M)
New York—Travis, Judson C. (M)
Saratoga Springs—Mallery, Harrie W. (A) (C/S—S-A)

Ohio
Genoa—Langa, Stephen P. (A)
Westlake—Schwartzenberg, Wade L. (J)

Oklahoma
Tulsa—Sharpe, Joseph A. (M) (R. M)

Oregon
Troutdale—Pope, Charles R. (J)

Pennsylvania
Allentown—Yost, Charles W. (J)
Barnesboro—Todhunter, John S. (J) (C/S—S-J)
Bethlehem—Hole, Gilbert L. (M)
Cornwall—Perhac, George A. (J) (R. C/S—S-J)
Fort Fort—Turoski, Stanley A. (M)
Jonestown—Harris, William W. (M)
Pittsburgh—Donath, Ernest E. (M)
Pittsburgh—Wilson, Philip J., Jr. (M)

Tennessee
Isabella—Jones, Jack Q. (M) (C/S—A-M)
Lookout Mount—Blair, James C. (M) (R. M)

Utah
Lark—Nealley, Roy D. (A)
Park City—Gilbert, Ray E. (M) (R. M)
Salt Lake City—Buchman, Howard M. (A)
Salt Lake City—Gile, Wendell E. (A)
Salt Lake City—Koza, Donald R. (J) (R. C/S—S-J)

Vermont
South Strafford—Brown, H. Gassaway III (J) (C/S—S-J)

Virginia
Cambria—Shufflebarger, Thomas E. Jr. (J) (C/S—A-J)
McLean—Carman, Everett P. (M)

Washington
Colville—Canning Brian P. (J) (R. C/S—S-J)
Spokane—Kindahl, Anders, G. (M)

West Virginia
Charleston—Smith, Veleair, C. II (J)
Gilbert—Robinette, Roy C. Jr. (J) (C/S—S-J)
Welch—Green James Jr. (J) (C/S—S-J)
Wheeling—Davis, Eugene T. (M) (R. M)

Wisconsin
Milwaukee—Rossi, Eugene F. (J) (R. C/S—S-J)
Milwaukee—Wiedenhoefer, Theodore C. (M)

Alaska
Juneau—Williams, John R. (J)

Belgium
Seraing—Vandestrick, Franz A. (M) (R. M)

Bolivia
Pulacayo—Hanguist, Olof, A. T. (A)

British Columbia
Kimberley—Kent, Aldwyn F. (M)

Canada
Ontario—Buchanan, Edward D. (M)
Ontario—Moffat, William W. (M) (C/S—J-M)

England
Lancs—Smee, Alan (J) (C/S—S-J)

Germany
Mitterteich—Spross, Werner (J) (C/S—S-J)

Peru
Casapalaca—Lizarraga, Luis H. (M) (C/S—A-M)
Lima—Camino, Fernando E. (M)
Lima—Diaz Dulanto, Oscar F. (M)
Miraplores—Jones, Erwin B. (M)

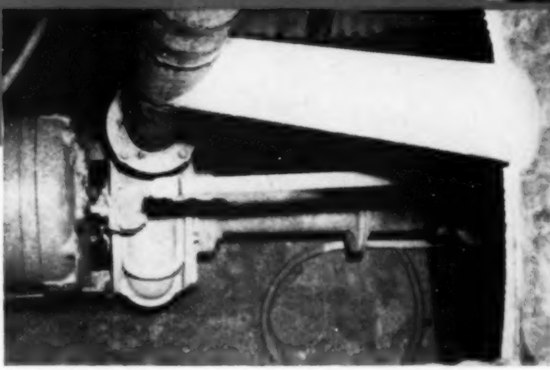
South America
British Guiana—Bennett, Malcolm G. (A) (R. C/S—J-A)

West Africa
Portuguese—Sousa-Machado, Francisco Jose', R. (A)
Portuguese—Vieira, Henrique (M)

Advertisers' Index

Pumping sand at Sierra

Sierra
ROCK
PRODUCTS CO



Frame BC-3-5 Hydroseal Sand Pump in pump pit.

Discharge from pump handling classifier overflow.

The men at Sierra Rock Products Co., Monrovia, California, swear by the Hydroseal Sand Pump that handles the classifier overflow in their sand washing process. Like the rest of its brethren in the mining world, it can be depended on to maintain its efficiency long after other pumps have said "uncle," because close clearances are protected from wear by clear sealing water. Besides reducing repair costs, this unique design feature results in greatly lowered power requirements.

Yes, mill men expect more from Hydroseals . . . and they *get* more.

Find out for yourself—write for our latest catalog No. 451

THE ALLEN-SHERMAN-HOFF PUMP CO.

Dept. C—259 E. Lancaster Ave., Wynnewood, Pa.

Representatives in Most Principal Cities

HYDROSEAL

SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED

HYDROSEAL PACKLESS AND MAXIMIX DESIGNS ARE COVERED BY PATENTS AND APPLICATIONS IN THE MAJOR MINING CENTERS OF THE WORLD

ASSURING Peak PRODUCTION and Maximum SAFETY in the nation's most productive mines . . .

EDISON LAMPS

More and better light is the answer to the greater output that's built into mechanized equipment—for miners, like motorists, can't "overdrive their vision."

The evidence of the Edison Lamp's ability to fill this illumination need with greater safety is provided by the army of users.

When you have a safety problem,
M.S.A. is at your service.
Our job is to help you.

MSA
SAFETY EQUIPMENT HEADQUARTERS

MINE SAFETY APPLIANCES COMPANY

Braddock, Thomas and Meade Sts., Pittsburgh 8, Pa.

At Your Service: 67 Branch Offices in the United States and Mexico

MINE SAFETY APPLIANCES CO. OF CANADA, LIMITED

Toronto, Montreal, Calgary, Winnipeg, Vancouver, New Glasgow, N.S.

Cable Address: "Minsaf" Pittsburgh

MINING ENGINEERING

IN TWO SECTIONS — SECTION TWO
JUNE 1952, VOL. 4, No. 6

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, INC.

FOUNDED 1871

1952 DIRECTORY OF OFFICERS, DIVISIONS, LOCAL SECTIONS, STUDENT CHAPTERS AND COMMITTEES

CORRECTED TO MAY 1, 1952

Published by the

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, INC.

29 West 39th St., New York 18, N. Y.

Telephone: Pennsylvania 6-9220

Cable: AIME, New York

TABLE OF CONTENTS

Printed in U. S. A.

OFFICERS AND DIRECTORS
1952

PRESIDENT
Michael Lawrence Haider[2]
New York City

PAST PRESIDENT
Willis McGerald Peirce[2]
New York City

VICE-PRESIDENTS
O. B. J. Fraser[3], New York City
J. L. Gillson[2], Wilmington, Del.
Philip Kraft[1], New York City
J. B. Morrow[3], Pittsburgh, Pa.
L. F. Reinartz[2], Middletown, O.
R. W. Thomas[1], Tucson, Ariz.

PRESIDENT-ELECT AND TREASURER
Andrew Fletcher[1], New York City

DIRECTORS
H. Decker[1], Houston, Tex.
F. B. Foley[1], Bayonne, N. J.
D. H. McLaughlin[1], San Francisco, Calif.
E. C. Meagher[1], New York City
C. V. Millikan[1], Tulsa, Okla.
G. F. Moulton[1], New York City
H. I. Young[1], St. Louis, Mo.
C. E. Lawall[2], Huntington, W. Va.
F. W. Libbey[2], Portland, Ore.
T. G. Moore[2], New York City
W. S. Morris[2], Kilgore, Tex.
J. F. Myers[2], Copperhill, Tenn.
A. C. Rubel[2], Los Angeles, Calif.
C. H. Benedict[3], Lake Linden, Mich.
R. B. Caples[3], Great Falls, Mont.
T. B. Counselman[3], Stamford, Conn.
T. L. Joseph[3], Minneapolis, Minn.
C. E. Reistle, Jr.[3], Houston, Tex.

DIVISION AND BRANCH CHAIRMEN—DIRECTORS EX OFFICIIS
A. Lee Barrett (Coal), Franklin, Pa.
Ian Campbell (Industrial Minerals), Pasadena, Calif.
E. H. Crabtree, Jr., (Minerals Beneficiation), Miami, Okla.
Walter A. Dean (Institute of Metals), Cleveland, O.
T. D. Jones (Extractive Metallurgy), Barber, N. J.
Evan Just (Mineral Economics), New York City
K. C. McCutcheon (Iron & Steel), Ashland, Ky.
Harry H. Power (Mineral Industry Education), Austin, Tex.
LeRoy Scharon (Mining, Geology, and Geophysics), St. Louis, Mo.
Paul R. Turnbull (Petroleum), Corpus Christi, Tex.
R. E. Byler (Mining Branch Council), San Francisco, Calif.
R. M. Brick (Metals Branch Council), Philadelphia, Pa.

SECRETARY
Edward H. Robie
29 West 39th St.
New York 18, N. Y.

ASSISTANT SECRETARIES
Joe B. Alford
H. Newell Appleton
John V. Beall
E. J. Kennedy, Jr.
E. O. Kirkendall
Roy E. O'Brien

[1]Director until Feb. 1953 [2]Director until Feb. 1954 [3]Director until Feb. 1955

PUBLICATIONS MANAGER
John V. Beall

ASSISTANT TREASURER
Peter J. Apol

FIELD SECRETARY
Roy E. O'Brien

CONTROLLER
George I. Brigden

COUNSEL
Bannister, Stitt, Holloway & Krause
40 West 40th Street
New York 18, N. Y.

STANDING COMMITTEES
1952

EXECUTIVE COMMITTEE OF THE BOARD OF DIRECTORS
M. L. Haider, Chairman
Philip Kraft, Vice-Chairman
T. B. Counselman
Evan Just
J. B. Morrow

FINANCE COMMITTEE OF THE BOARD OF DIRECTORS
Gail F. Moulton, Chairman
L. F. Reinartz
W. M. Peirce

INVESTMENTS
Erle V. Daveler, Chairman, '54
Henry Krumb, '53
W. M. Peirce, '55
Gail F. Moulton, *ex officio Chairman, Finance Committee*
Andrew Fletcher, *ex officio Treasurer, AIME*

LOCAL SECTION APPROPRIATIONS
Clyde Williams, Chairman
E. R. Kaiser
John H. Melvin

ENDOWMENT FUND "X"
Andrew Fletcher, Chairman
Erle V. Daveler, '55
Philip Kraft, '53
Franz Schneider, '54

HONORARY MEMBERSHIPS
W. E. Wrather, Chairman
L. E. Young, '53
D. H. McLaughlin, '53
Leo F. Reinartz, '53
Henry Krumb, '54
John M. Lovejoy, '55
W. M. Peirce, '56

ADMISSIONS
T. D. Jones, Chairman
T. G. Moore, Vice-Chairman

A. C. Brinker	G. P. Lutjen
Harold S. Bell	T. W. Nelson
R. H. W. Chadwick	J. H. Scaff
C. A. R. Lambly	C. L. Rice, Jr.
F. W. Hanson	E. A. Prentis
Ivan A. Given	J. T. Sherman

MEMBERS' CONDUCT
L. E. Young, Chairman

John R. Suman	Clyde Williams

ENDOWMENT

Wilfred Sykes, Chairman	E. DeGolyer	Henry Krumb	Leo Reinartz
N. G. Alford	J. V. N. Dorr	D. H. McLaughlin	J. F. Suman
W. J. Coulter	D. C. Jackling	W. W. Mein	C. E. Weed
E. V. Daveler	O. H. Johnson	H. S. Mudd	W. E. Wrather

ROCKY MOUNTAIN INCOME

Henry Krumb, Chairman, '56
Philip Kraft, '54
Harvey S. Mudd, '53

SEELEY W. MUDD MEMORIAL FUND

H. DeWitt Smith, Chairman, '53
J. G. Baragwanath, '54
Harvey S. Mudd, '55
M. L. Haider, ex officio
E. H. Robie, ex officio

GEMMELL MEMORIAL FUND

D. C. Jackling, Chairman, '53
J. M. Boutwell, '54
E. W. Engelmann, '55
D. D. Moffat, '56
Louis S. Cates, '57

HENRY L. DOHERTY MEMORIAL FUND

John M. Lovejoy, Chairman
E. DeGolyer
Warren A. Sinsheimer

ROSSITER W. RAYMOND MEMORIAL AWARD

J. S. Smart, Jr., Chairman, '55
N. G. Alford, '53
M. G. Gulley, '54
B. J. Larpenteur, '56
M. B. Gentry, '57
Jack I. Landermilk, *Chairman, Technical Publications Committee, ex officio*

ROBERT H. RICHARDS AWARD

Elmer Isern, Chairman, '53
Fred DeVaney, '53
John F. Myers, '54
E. H. Rose, '54
S. J. Swainson, '55
T. B. Counselman, '55
R. E. Byler, '56
G. J. Holt, '56
E. H. Crabtree, Jr., *Chairman, Minerals Beneficiation Division, ex officio*

RAND FOUNDATION AWARD

W. E. Wrather, Chairman, '53
S. F. Bowlby, '53
Clyde E. Wood, '54
Paul D. Merica, '54
Philip R. Bradley, Jr., '55
Thomas G. Chapman, '55
P. D. I. Honeyman, '56
W. M. Peirce, '56
M. L. Haider, President AIME, *ex officio*

DOUGLAS METALLURGICAL MEDAL

H. W. Hardinge, Chairman, '53
E. A. Anderson, '53
W. E. Remmers, '53
A. D. Turnbull, '53
John E. Dorn, '54
John D. Sullivan, '54
J. D. MacKenzie, '54
S. J. Swainson, '54
C. F. Milkwick, '55
J. C. Kinnear, Jr., '55
S. E. Woodworth, '55
Clair Upthegrove, '55
C. L. Pringle, '56
Albert A. Smith, Jr., '56
Francis B. Foley, '56
C. D. King, '56
M. L. Haider, *ex officio*

SAUNDERS MINING MEDAL

R. L. McCann, Chairman, '54
J. A. Carpenter, '53
E. S. McGlone, '53
D. D. Moffat, '53
Cadwallader Evans, Jr., '53
R. P. Koenig, '54
Ross D. Leisk, '54
Herman J. Mutz, '54
R. F. Goodwin, '55
M. M. Leighton, '55
Arthur Notman, '55
A. F. Peterson, '55
B. R. Coil, '56
W. H. Goodrich, '56
Wesley P. Goss, '56
H. N. Eavenson, '56
M. L. Haider, *ex officio*

LUCAS PETROLEUM MEDAL

Fred M. Nelson, Chairman, '53
J. E. Brantly, '53
W. E. Pratt, '53
Lloyd E. Elkins, '54
John H. Murrell, '54
W. H. Geis, '54
R. F. Baker, '55
*M. L. Haider, '55
J. E. Sherborne, '55
I. W. Alcorn, '56
E. C. Gaylord, '56
W. E. Wrather, '56

Members ex officiis

John J. Forbes, Director, U. S. Bureau of Mines
Frank N. Porter, President, American Petroleum Institute
*M. L. Haider, President, AIME
Morgan J. Davis, President, American Association of Petroleum Geologists

ERSKINE RAMSAY COAL MEDAL

Evan Evans, Chairman, '53
Clayton G. Ball, '53
H. P. Greenwald, '54
R. H. Swallow, '54
C. E. Lawall, '55
H. F. Yancey, '55
V. O. Murray, '56
Paul Weir, '56
M. L. Haider, *ex officio*

TECHNICAL PUBLICATIONS COMMITTEE

October 1951 to October 1952

Jack I. Laudermilk, Chairman
Vinton H. Clarke, Vice-Chairman
Charles H. Lambur, Vice-Chairman
E. J. Kennedy, Jr., Secretary

Robert H. Aborn — M. D. Hassialis
John R. Atkinson — E. P. Lange
W. H. Callahan — W. Harrison Loerpabel
Charles W. Eichrodt — Robert D. Nininger
Francis B. Foley — Earl W. Palmer
J. S. Smart

Members ex officiis

Joe B. Alford — E. O. Kirkendall
H. N. Appleton — R. E. O'Brien
John Beall — E. H. Robie

AUXILIARY PUBLICATIONS COMMITTEES

COAL DIVISION

Harold P. Greenwald, Chairman

David H. Davis — Raymond C. Johnson
Carroll F. Hardy — H. J. Rose
G. Albert Shoemaker
James A. Younkins

INDUSTRIAL MINERALS DIVISION

Bruce C. Netschert, Chairman

H. H. Bannerman — H. I. Smith
J. A. Barr, Sr. — R. W. Smith

MINERALS BENEFICIATION DIVISION

M. D. Hassialis, Chairman

S. R. B. Cooke — S. D. Michaelson
F. M. Lewis — T. M. Morris
F. W. McQuiston, Jr. — H. Rush Spedden

MINING, GEOLOGY, AND GEOPHYSICS DIVISION

Mining Subdivision

Ross D. Leisk, Chairman

Malcolm C. Brown — G. T. Harley
John Edgar — Roy S. Hooper
Rollin Farmin — R. W. Hughes
Joseph C. Kieffer

Geology Subdivision

Edward Wisser, Chairman

A. L. Anderson — Charles Meyer
R. H. McConnell — James A. Noble
F. S. Turneaure

Geophysics Subdivision

Florence Robertson, Chairman

R. R. Heinrich — H. L. Scharon

INSTITUTE OF METALS DIVISION

M. Gensamer, Chairman

W. M. Baldwin, Jr. — Max Hansen
P. A. Beck — H. H. Hausner
Morris Cohen — W. R. Hibbard, Jr.
L. S. Darken — J. M. Hodge
Pol Duwez — J. R. Low, Jr.
W. L. Fink — R. B. Mears
A. H. Geisler — R. F. Mehl
T. A. Read

IRON AND STEEL DIVISION

Andrew G. Forrest, Chairman

Myron Jones — M. Tenenbaum
Earl Pierce — F. M. Washburn
T. F. Plimpton — Otto Zmeskal

EXTRACTIVE METALLURGY DIVISION

Julian Glasser, Chairman

John D. Sullivan — S. F. Ravitz
Ronald R. McNaughton

PETROLEUM DIVISION

John P. Hammond, Chairman
Richard A. Morse, Vice-Chairman
Joe H. Field
Mac D. Oliver
G. C. MacDonald
E. K. Schluntz
John A. Murphy
Marshall B. Standing
H. A. Welge

MINERAL ECONOMICS DIVISION

Herbert A. Franke, Chairman
Edwin L. Kennedy
Allan F. Matthews
Orville R. Lyons
Maurice Peloubet

MINERAL INDUSTRY EDUCATION DIVISION

John P. Nielsen, Chairman
J. Donald Forrester
W. B. Plank
H. R. Gault
W. J. Rundle

COORDINATING TECHNICAL PROGRAM FOR THE ANNUAL MEETING

E. J. Kennedy, Jr., Chairman
Ralph Textor (Coal)
George D. Dub (Industrial Minerals)
Donald Scott (Minerals Beneficiation)
B. R. Queneau (Iron and Steel)
R. S. Busk (Institute of Metals)
P. T. Stroup (Extractive Metallurgy)
Tell Ertl (Mining Subdivision)
Edward L. Clark Theodore Koulomzine (Geology Subdivision)
Kenneth L. Cook, (Geophysics Subdiv.)
J. K. Richardson (Mineral Economics)
John Nielsen (Mineral Industry Education)

AIME PENSION TRUST

Paul D. Merica, Chairman
Louis S. Cates
John M. Lovejoy
P. J. Apel, Secretary

STUDENT RELATIONS

M. D. Cooper, Chairman
H. N. Appleton, Secretary
George Bator
Clark B. Carpenter
James D. Forrester
John C. Calhoun, Jr.
Charles Holland
T. G. Chapman
P. D. I. Honeyman
Gilbert Doan
C. W. Mason
C. R. Dodson
W. S. Morris
George Enos
Ralph Nielsen
Paul Fitzgerald
E. P. Pfleider
H. H. Power
J. W. Spretnak
L. C. Raymond
W. A. Staab
Frederick N. Rhines
J. U. Teague
James K. Richardson
C. A. Warner
Vernon E. Scheid
A. W. Walker
H. Rush Spedden
H. C. Woods

SUBCOMMITTEE ON STUDENT PRIZE PAPER AWARDS

William A. Staab, Chairman
Ralph F. Nielsen
J. W. Spretnak

LIBRARY

Executive Committee

Frank T. Sisco, Chairman, '54
E. H. Robie, Secretary AIME, *ex officio*
H. R. Aldrich
R. F. Miller
J. Z. Briggs
W. M. Peirce
Louis Jordan
Harold J. Rose

COOPERATION WITH THE CANADIAN INSTITUTE OF MINING AND METALLURGY

Sherwin F. Kelly, Chairman
Alan E. Cameron
W. G. Hubler
C. Camsell
A. Ignatieff
A. B. Cummins
Philip Kraft
R. W. Diamond
Hans Lundberg
J. A. Drain
V. R. MacMillan
Norman R. Fisher
R. R. McNaughton
Horace J. Fraser
R. G. K. Morrison
C. Gerow
D. A. Pifer
H. M. Griffith
J. A. Retty
R. M. P. Hamilton
N. C. Pearce
Ira K. Hearn
H. L. Roscoe
Oliver Hopkins
Hugh Spence
L. E. Young

SEELEY W. MUDD SERIES VOLUME ON HEALTH AND SAFETY IN MINING

Editorial Advisory Board

Clarence M. Haight, Chairman
J. J. Carrigan
Daniel Harrington
George H. Deike
Theodore Marvin
Oscar A. Glaeser
T. C. Murdock
R. R. Sayers
R. Dawson Hall, Editor

SEELEY W. MUDD SERIES VOLUME ON MECHANICAL LOADING AND HAULAGE IN UNDERGROUND MINES

Editorial Advisory Board

Cadwallader Evans, Jr., Chairman

L. C. Campbell
W. J. Coulter
Lucien Eaton
R. T. Elstad
Andrew Fletcher
G. T. Harley
C. T. Hayden
R. E. Kirk
Eugene McAuliffe
D. L. McElroy
R. E. Salvati
Louis Ware
Clyde E. Weed
L. E. Young, Editor

COMMITTEE ON NOMINATIONS FOR 1953 AIME OFFICERS

(*Names in parentheses are alternates*)

John R. Suman, Chairman
(Henry T. Mudd)
Francis Cameron (Philip D. Wilson)
Henry A. Dierks (D. C. Helms)
P. G. Spilsbury (Thomas H. Miller)
William A. Mueller (Harley Lee)
Thomas M. Broderick
(Raymond D. Satterly)
Armor B. Martin (T. K. Graham)
Drury A. Pifer (Albert H. Mellish)
George D. Dub (Basil Kantzer)
Edward M. Tittman (Guy E. Ingersoll)
S. S. Clarke (John W. Chandler)
Edwin R. Price (J. Murray Riddell)
C. H. Behre, Jr. (Grover Holt)
John D. Sullivan (Maxwell Gensamer)
John E. Sherborne (Lloyd Elkins)
George P. Halliwell
H. M. Griffith (C. D. King)
Maxwell Gensamer (Max Ball)

GENERAL MEMBERSHIP

(*Committee is composed of chairmen of Local Section and Division Committees on Membership.*)

T. B. Counselman, Chairman
O. B. J. Fraser, Vice-Chairman
H. N. Appleton, Secretary

DIVISION

Coal—Gerald R. Spindler
Extractive Metallurgy—R. D. Bradford
Industrial Minerals—A. O. Bartell
Institute of Metals—W. J. Harris
Iron and Steel—T. J. McLoughlin
Mineral Economics—Roland D. Parks
Mineral Industry Education—
Eugene M. Thomas
Minerals Beneficiation—J. P. Bonardi
Mining, Geology and Geophysics:
Mining Subdivision—Leland A. Walker
Geology Subdivision—Clayton G. Ball
Geophysics Subdivision—Homer Jensen
Petroleum—Jack M. Moore

LOCAL SECTION

Alaska—Douglas B. Colp
Arizona—
Black Hills—Gerald Van Duzee
Boston—A. M. Gaudin
Carlsbad Potash—H. P. Clark
Central Appalachian—
Chicago—Dennis Carney
Cleveland—R. F. Hehemann
Colorado—Asher Patten
Columbia—John W. Lowry
Connecticut—William Mounce
Delta—A. H. Glenn
Detroit—
East Texas—G. L. Scheirman
El Paso Metals—E. W. Donahue
Flordia—John Yost
Gulf Coast—A. S. Trube
Kansas—J. T. Gary
Lehigh Valley—R. M. Johnson
Mid-Continent—
Minnesota—
Montana—R. C. Weisner
Nevada—H. B. Chessher, Sr.
New York—
North Pacific—D. A. Somerville
North Texas—R. H. Rantala, *Forth Worth*
K. F. Anderson, *Dallas*
B. J. Miller, *Wichita Falls*
Ohio Valley—William Newton
Oklahoma City—
Oregon—D. H. Beetem
Penna-Anthracite—J. T. Griffiths
Permian Basin—R. P. Kirk
Philadelphia—E. Korostoff
Pittsburgh—E. H. Hollingsworth
St. Louis—J. C. George
San Francisco—J. C. Lokken
Southeast—Frank Doyle
Southern California—C. M. Berndt
Southwest Texas—

Southwestern Alaska—
Southwestern New Mexico—W. C. Word
Tri-State—Ernest Blessing
Upper Peninsula—F. W. Denton
Utah—B. L. Sackett
Washington, D. C.—S. P. Wimpfen
Wyoming—I. M. Charles
Mexico—Alex Edelen
Philippine—
Rio de Janeiro—

OFFICIAL AIME REPRESENTATIVES

UNITED ENGINEERING TRUSTEES, INC.

James L. Head, '55
Gail F. Moulton, '53
E. C. Meagher, '53

Advisory Committee to Real Estate Committee

Cleveland Dodge
Paul D. Merica
Herbert Hoover

THE ENGINEERING FOUNDATION

E. R. Kaiser, '54
E. C. Meagher, ex officio as President, UET
W. M. Peirce, '52

Research Procedure Committee
E. R. Kaiser

ENGINEERING SOCIETIES LIBRARY BOARD

James L. Head, Chairman

Frank T. Sisco, '54
E. M. Wise

AMERICAN STANDARDS ASSOCIATION

Mining Standardization Correlating Committee

Otto Herres, '53
J. K. Richardson, '53
E. W. Bullard, '53 — Alternate
H. H. Otto, '53

A.S.A. SECTIONAL COMMITTEES:

B30—*Safety Code for Cranes, Derricks and Hoists*	Bert H. Puerner
B52—*Classification of Tools, Fixtures and Gages*	L. A. Danse
B58—*Deep Well Vertical Pumps*	James A. Barr
C34—*Mercury Arc Rectifiers*	S. E. Maddigan
C61—*Electric and Magnetic Magnitudes and Units*	C. A. Heiland

M 2—*Electrical Equipment in Coal Mines*	A. Lee Barrett C. C. Conway
M 6—*Drainage of Coal Mines*	W. L. Alfelder R. E. Hobart
M11—*Wire Rope for Mines*	E. R. Borcherdt
M12—*Construction and Maintenance of Ladders and Stairs for Mines*	Clarence E. Berner M. D. Cooper, alternate John W. Buch, alternate
M13—*Rock-Dusting Coal Mines to Prevent Coal Dust Explosions*	H. N. Eavenson, Chairman
M15—*Safety Code for Coal Mine Transportation*	Alfred W. Hesse
M17—*Fire Fighting Equipment in Metal Mines*	E. M. Norris
M24—*Electrical Equipment in Metal Mines*	Graham Bright A. C. Stevenson
Y32—*Graphical Symbols and Designations*	A. H. Hubbell
Z11—*Petroleum Products and Lubricants*	K. G. MacKenzie, Chairman George H. Taber, Jr., alternate
Z23—*Sieves for Testing Purposes, Specifications for*	J. B. Morrow A. F. Taggart
Z41—*Performance Requirements for Protective Occupational Footwear*	W. H. Lesser
Y 1—*Abbreviations*	A. F. Taggart
Y10—*Letter Symbols*	T. E. Lloyd
Z59—*Fluid Permeation*	Morris Muskat George Fancher, alternate

NATIONAL RESEARCH COUNCIL

Division of Engineering and Industrial Research
Oliver C. Ralston

JOHN FRITZ MEDAL BOARD OF AWARD

W. E. Wrather, '52
L. E. Young, '53
D. H. McLaughlin, '54
W. M. Peirce, '55

HOOVER MEDAL BOARD OF AWARD

Scott Turner, '56, Chairman
Paul D. Merica, '54
Cadwallader Evans, Jr., '57

ALFRED NOBLE PRIZE COMMITTEE

L. E. Young, '56

JOSEPH A. HOLMES SAFETY ASSOCIATION

S. H. Ash

WASHINGTON AWARD COMMISSION

R. A. Lindgren, '53
William E. Mahin, '54

AIME REPRESENTATIVES ON ENGINEERS JOINT COUNCIL

W. M. Peirce
L. E. Young

James L. Head, *Alternate*
M. L. Haider,
President AIME, ex officio
E. H. Robie,
Secretary AIME, ex officio
J. V. Beall,
Editor "Mining Engineering"

EXECUTIVE COMMITTEE

L. E. Young
J. L. Head, *Alternate*

ENGINEERING MANPOWER COMMISSION

George Corless
H. K. Work
E. H. Robie,
Secretary AIME, ex officio

INCREASED UNITY OF THE ENGINEERING PROFESSION

James L. Head

SPECIAL SURVEYS

M. D. Cooper

INTERNATIONAL RELATIONS

J. T. Duce C. W. Wright
E. H. Robie

TECHNICAL ASSISTANCE

J. W. Barker A. B. Kinzel
F. T. Sisco

NATIONAL WATER POLICY

E. L. Clark

ENGINEERING SCIENCES

A. M. Gaudin R. M. Brick

SALARY STABILIZATION

John V. Beall E. H. Robie

LABOR LEGISLATION

Francis B. Foley

NATIONAL ENGINEERS

Julian Conover M. J. Jameson, Jr.

ENGINEERS IN CIVIL SERVICE

W. H. Wagner

SECRETARIES

E. H. Robie

CONSTITUTION AND BY-LAWS

J. L. Head

ENGINEERS COUNCIL FOR PROFESSIONAL DEVELOPMENT

Curtis L. Wilson, '52
J. R. Cudworth, '53
C. E. Lawall, '54

COMMITTEES

Training—D. R. McKeithan, Oct. '52
Education—Curtis L. Wilson, Oct. '52
Recognition—Robert L. Hallett, Oct. '52
Guidance—M. D. Cooper
Student Development—Roland D. Parks

JOINT COMMITTEE ON ENGINEERING SOCIETIES MONOGRAPHS

Reed W. Hyde, Oct. '52
J. I. Laudermilk, *ex officio as Chairman Technical Publications Committee*, Oct. '52

ENGINEERING INDEX

Frank T. Sisco, '55

COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

C. Baldwin Sawyer, '52
O. B. J. Fraser, '52

AMERICAN DOCUMENTATION INSTITUTE

Francis B. Foley, Jan. '53

AMERICAN GEOLOGICAL INSTITUTE

J. L. Gillson, '52
George Fowler, '53

COMMITTEE ON GLOSSARY OF GEOLOGICAL TERMS

W. T. Schaller

PROFESSIONAL BRANCHES AND DIVISIONS OFFICERS AND COMMITTEES

BRANCH COUNCILS

MINING BRANCH

R. E. Byler, '53, Chairman (Minerals Beneficiation)
C. M. Cooley, Acting Secretary
A. Lee Barrett, '54, (Coal)
Carroll A. Garner, '53, (Coal)
E. H. Crabtree, '54, (Minerals Beneficiation)
Ian Campbell, '54, (Industrial Minerals)
A. B. Cummins, '53, (Industrial Minerals)
E. D. Gardner, '53, (Mining, Geology, and Geophysics)
LeRoy Scharon, '54, (Mining, Geology, and Geophysics)
R. T. Gallagher, (Mineral Industry Education)
John H. Ffolliott, (Mineral Economics)

METALS BRANCH

R. M. Brick, Chairman, (Institute of Metals)
Ernest Kirkendall, Secretary
K. C. McCutcheon, (Iron and Steel)
T. L. Joseph, (Iron and Steel)
W. A. Dean, (Institute of Metals)
Oliver Ralston, (Extractive Metallurgy)
T. D. Jones, (Extractive Metallurgy)
Roland D. Parks, (Mineral Economics)
D. S. Eppelsheimer, (Mineral Industry Education)

JOURNAL OF METALS EDITORIAL ADVISORY COMMITTEE

H. K. Work, Chairman

L. F. Reinartz
W. A. Dean
R. D. Bradford
J. S. Smart, Jr.
J. C. Kinnear, Jr.
Evan Just

PETROLEUM BRANCH

Paul R. Turnbull, Chairman
R. W. French, Past Chairman
Morris Muskat, Vice-Chairman
John R. McMillan, Vice-Chairman
William E. Stiles, Treasurer
Joe B. Alford, Executive Secretary
C. R. Dodson, (Mineral Industry Education)
John S. Bell
D. V. Carter
R. C. Earlougher
T. C. Frick
E. N. Van Duzee
G. L. Yates
L. C. Raymond (Mineral Economics)

INSTITUTE OF METALS DIVISION

Ferrous and Nonferrous Physical Metallurgy
(By-laws in Transactions, Vol. 156, 1944)

Established as a Division April 26, 1918

Walter A. Dean, Chairman
R. M. Brick, Past-Chairman
Morris Cohen, Senior Vice-Chairman
J. H. Scaff, Vice-Chairman
Ernest Kirkendall, Secretary-Treasurer

COMMITTEES

EXECUTIVE

J. B. Austin, '54
W. M. Baldwin, Jr., '53
P. A. Beck, '53
G. P. Halliwell, '55
W. R. Hibbard, Jr., 54
W. E. Mahin, '55
O. T. Marzke, '55
C. H. Samans, '54
A. Squire, '53

NOMINATING (1 Yr.)

R. M. Brick, Chairman
E. H. Dix, Jr.
E. E. Schumacher
M. Gensamer
C. E. Swartz

FINANCE (1 Yr.)

J. D. Hanawalt, Chairman
K. H. Donaldson
N. B. Pilling
C. F. Floe
A. J. Smith

ANNUAL LECTURE (1 yr.)

W. C. Ellis, Chairman
M. Cohen
T. Leontis
J. H. Hollomon
G. A. Moore

MATHEWSON GOLD MEDAL

M. B. Bever, Chairman
A. H. Geisler
J. R. Low, Jr.
B. W. Gonser
A. Troiano

EDUCATION

R. M. Brick, Chairman
W. F. Hess
Robert Mears

PUBLICATIONS

(Oct. 15, 1951 to Oct. 15, 1952)
M. Gensamer, Chairman
W. M. Baldwin, Jr.
Max Hansen
P. A. Beck
H. H. Hausner
M. Cohen
W. R. Hibbard, Jr.
L. S. Darken
J. M. Hodge
Pol Duwez
J. R. Low, Jr.
W. L. Fink
R. B. Mears
A. H. Geisler
R. F. Mehl
T. A. Read

MEMBERSHIP

(Terms expire February of year indicated)
W. J. Harris, Chairman, '53
D. I. Finch, Vice-Chairman, '53
J. P. Nielsen, Vice-Chairman, '53
B. L. Averbach, '54
L. K. Jetter, '55
W. B. Brooks, '53
J. M. Kiefer, '53
J. E. Burke, '53
R. Maddin, '54
L. Carapella, '54
F. R. Morral, '53
G. Edmunds, '55
T. Oberle, '55
R. L. Fullman, '54
R. A. Quadt, '54
B. W. Gonser, '53
C. C. Shepard, '53
A. J. Herzig, '53
J. K. Stanley, '54
A. Hone, '53
A. M. Talbot, '53
R. Hultgren, '54
L. W. Thelin, 54
S. F. Urban '53

DATA SHEET (1 yr.)

A. I. Blank, Chairman
R. M. Brick
E. N. Skinner
F. N. Rhines
J. S. Smart, Jr.
A. U. Seybolt
D. W. Smith
E. M. Wise

PROGRAMS

(Terms expire February of year indicated)
R. S. Busk, Chairman, '54
J. H. Scaff, Vice-Chairman Spec. '53
R. D. Chapman, Vice-Chairman Tech. '54
A. U. Seybolt, Vice-Chairman Supvr. Arrgt. '54
F. J. Dunkerley, Vice-Chairman Phila. '55

Pol Duwez, Vice-Chairman

Los Angeles '55

B. H. Alexander, '53
B. L. Averbach, '54
D. J. Blickwede, '55
H. I. Dixon, '55
D. S. Eppelsheimer, '53
G. P. Halliwell, '53
M. F. Hawkes, '54
H. Y. Hunsicker, '55
A. Jones, '55
F. M. Linsmayer '54
V. Pulsifer, '53
R. A. Quadt, '55
T. A. Read, '55
J. S. Smart, Jr. '53
D. Turnbull, '54
H. L. Walker, '54
R. Ward, '53
F. H. Wilson, '55
D. Woodward, '54
O. Zmeskal, '54

POWDER METALLURGY

J. C. Redmond, Chairman, '54
J. J. Cordiano, Past-Chairman, '53
J. F. Kuzmick, Vice-Chairman, '53
H. H. Hausner, Vice-Chairman and Secy. '54

R. S. Busk, '54
Pol Duwez, '54
C. G. Johnson, '53
G. A. Roberts '54
J. F. Sachse, '53
A. J. Shaler, '53
R. Steinitz, '53
E. F. Swazy, '54
C. J. Bier, '55
C. G. Goetzel, '55
Harold Hirsch, '55
J. F. Libsch, '55
P. V. Schneider, '55

PETROLEUM DIVISION

Established as a Division March 24, 1922

Paul R. Turnbull, Chairman
John R. McMillan, Vice-Chairman
Morris Muskat, Vice-Chairman
William F. Stiles, Treasurer
Joe B. Alford, Executive Secretary
406 Trinity Universal Building
Dallas, Texas

COMMITTEES

EXECUTIVE

For Executive Committee see Branch Council Page No. 10

EDITORIAL BOARD

Paul R. Turnbull
Richard W. French
Thomas C. Frick

ADVERTISING

Bruce Barkis, Chairman

P. E. Fitzgerald
W. K. Daggett
P. H. Jamison
Gail F. Moulton

ECONOMICS

Kenneth E. Hill, Chairman

EDUCATION

John C. Calhoun, Jr., Chairman

PRODUCTION REVIEW

E. W. Berlin, Chairman
R. B. Gilmore, *Domestic*
Alexander H. Chapman, *Foreign*

TECHNOLOGY

Douglas Ragland, Chairman
Jack H. Abernathy, *Drilling*
E. P. Hayes, *Production*
W. H. Justice, *Natural Gas*
Milton E. Joy, *California*

MEMBERSHIP

Jack M. Moore, Chairman

STUDENT ACTIVITIES

W. S. Morris, Chairman

PUBLIC RELATIONS

John P. Hammond, Chairman
R. A. Morse, Vice-Chairman

Joe H. Field
John A. Murphy
E. K. Schluntz
G. C. MacDonald
Mac D. Oliver
Marshall B. Standing
H. J. Welge

NOMINATIONS

R. W. French, Chairman
J. C. Calhoun, Jr. H. F. Beardmore
H. S. Kelly M. B. Standing

ILLINOIS BASIN CHAPTER

L. W. Swanbeck, Chairman
J. R. Vaughn, Vice-Chairman (*Program*)
D. M. Moon, Vice-Chairman (*Membership*)
R. L. Shick, Secretary-Treasurer

EXECUTIVE COMMITTEE

Bob Diggs Brown
C. A. Hamman R. W. Love

DIRECTORS

L. A. Mylius W. C. Riggs
W. T. Roach

PACIFIC PETROLEUM CHAPTER

Wayne E. Glenn, Chairman
J. Shannon Baker, Secretary-Treasurer

COUNCIL

W. E. Glenn
J. Shannon Baker
C. R. Dodson
Basil P. Kantzer, Jr.
M. E. Loy
C. T. McClure
R. L. Parsons
N. Van Wingen, Sr.
F. L. Wadsworth

COMMITTEE CHAIRMEN

Paul Andrews, *Student Activity*
Milton E. Loy, *Program*
A. B. Dooley, *Field Trip*
E. E. Beauchamp, *Publicity*
D. M. Berut, *Membership*
L. W. Chasteen, *Prod. Statistics*
J. A. Koltz, *Journal Secretary*
A. H. Bell, *Dinner Dance*
W. E. Larson, *Exhibits*
Donald B. O'Neill, *Jr. Group*
W. E. Woodruff, *Luncheon Meeting*

PETROLEUM TECHNOLOGY COMMITTEE

S. T. Yuster, Chairman
W. T. Cardwell, Past Chairman-Adviser
G. B. Thomas, Jr. R. S. Crog

1952 LOS ANGELES FALL MEETING

Joseph Jensen, General Chairman

WYOMING PETROLEUM CHAPTER

Sidney B. Richards, Chairman
R. D. Stottlemeyer, Vice-Chairman
Program
F. R. Wheeler

SAN JOAQUIN VALLEY CHAPTER

Max C. Eastman, Chairman
R. P. Mangold, Program Chairman
Harry Campbell, Secretary
C. A. Davis, Treasurer
E. A. Armbruster, Membership Chairman

IRON AND STEEL DIVISION

Established as a Division
February 22, 1928

K. C. McCutcheon, Chairman
T. L. Joseph, Past Chairman
J. B. Austin, Vice-Chairman
E. K. Miller, Vice-Chairman
T. J. McLoughlin, Vice-Chairman
Ernest Kirkendall, Secretary-Treasurer

COMMITTEES

EXECUTIVE

J. A. Bowers '54 J. S. Marsh '55
R. W. Campbell '54 D. L. McBride '53
Walter Carroll '55 G. B. McMeans '53
K. L. Fetters '53 F. L. Toy '54
H. M. Griffith '55

Ex Officiis

J. J. Golden R. H. Frank
S. Naismith

PROGRAM

B. R. Queneau, Chairman
D. T. Rogers, Vice-Chairman

C. L. Altenburger J. G. Mravec
H. J. Forsyth D. W. Murphy
D. R. Loughrey Kurt Neustaetter
G. McMeans J. E. Stukel
W. E. Marshall M. Tenenbaum
A. B. Wilder

HOWE MEMORIAL

K. C. McCutcheon, Chairman

F. B. Foley, '56 T. L. Joseph, '54
H. W. Graham, '55 E. C. Smith, '53

ROBERT W. HUNT MEDAL AND PRIZE

K. C. McCutcheon, Chairman

Samrel Epstein, '53 V. W. Jones, '56
H. W. Johnson, '54 J. S. Marsh, '55

J. E. JOHNSON, JR., AWARD

Kurt Neustaetter, Chairman, '54

H. F. Dobscha, '53 Samuel Naismith, '56
B. J. Frost, '55 L. J. Tofft, '55

BESSEMER STEEL

A. B. Wilder, Chairman

S. J. Cresswell H. W. Graham
S. J. Dougherty E. R. Holstein
H. C. Dunkle W. G. McDonough
R. E. Edwards W. H. Mayo
L. R. Eisenhart J. M. Stone
K. L. Fetters E. B. Story
G. M. Yocum

TECHNICAL PUBLICATIONS

(Oct. 15, '51—Oct. 15, '52)

A. G. Forrest, Chairman

M. A. Jones M. Tenenbaum
E. W. Pierce F. M. Washburn
T. F. Plimpton Otto Zmeskal

MEMBERSHIP

H. E. Johnson, Chairman

E. J. Andberg V. W. Jones
R. M. Baker T. J. McLoughlin
H. H. Blosjo E. E. McGinley
J. R. Brady G. B. McMeans
K. P. Campbell A. K. Moore
W. H. Carpenter J. F. Pollack
Gordon Eaton W. J. Reagan
W. M. Farnsworth J. M. Stewart
R. B. Freemann M. Tenenbaum
E. J. Gardner A. W. Thornton
J. J. Golden C. Wyman

NOMINATING

T. L. Joseph, Chairman

H. W. Johnson L. F. Reinartz
E. K. Miller E. C. Smith

ELECTRIC FURNACE STEEL COMMITTEE

COMMITTEES

EXECUTIVE

R. H. Frank, Chairman, '52
Ernest Kirkendall, Secretary

H. H. Blosjo, '52 T. J. McLoughlin, '52
C. W. Briggs, '53 M. J. Meinen, '54
G. Derge ,'54 C. F. Staley, '53
J. P. Gill, '52 H. F. Walther, '52
M. E. Goetz, '53 Clyde Wyman, '54

MEMBERSHIP

T. J. McLoughlin, Chairman

H. H. Blosjo W. M. Farnsworth
Clyde Wyman

CONFERENCE

W. M. Farnsworth, Chairman, '52
F. O. Lemmon, Vice-Chairman, '52
Ernest Kirkendall, Secretary

S. Arnold, III, '53 J. S. Marsh, '52
J. H. Baldrey, '53 C. G. Mickelson, '53
L. W. Cashdollar, '54 A. C. Ogan, '52
D. L. Clark, '54 F. St. Vincent, '54
Wm. Doyle, '54 C. E. Sims, '54
R. H. Jacoby, '53 G. T. Stowe, '52
J. Juppenlatz, '52 V. E. Zang, '54

FINANCE

R. K. Kulp, Chairman

W. M. Charman, Jr. V. J. Nolan
H. E. Orr

LOCAL ARRANGEMENTS

Frank Weir, Chairman

L. R. Burke G. L. Robinson
N. G. Glanding, Jr. F. St. Vincent

OPEN HEARTH STEEL COMMITTEE

(April, '52—April, '53)

J. J. Golden, Chairman '54
A. H. Sommer, Past Chairman '53
L. R. Berner, Vice-Chairman '53
E. Kirkendall, Secy-Treas. '54

E. D. Buchanan '55
G. M. Burrier '53
C. E. Carr '55
T. A. Cleary '56
A. F. Franz '53
H. M. Griffith '53
H. G. Grim '55
C. F. Henzelman '53
V. W. Jones '55
T. L. Joseph '53
D. R. Loughrey '56
D. R. Mathews '53
G. B. McMeans '56
A. W. Thornton '56
H. J. Walker '55

COMMITTEES

MEMBERSHIP

A. W. Thornton, Chairman

A. K. Moore
R. M. Baker
J. F. Pollack
E. E. McGinley
V. W. Jones
J. R. Brady
W. H. Carpenter
G. B. McMeans

PHYSICAL CHEMISTRY OF STEELMAKING

C. R. Taylor, Chairman
L. S. Darken, Secretary
M. Tenenbaum, Past Chairman

D. E. Babcock
R. E. Birch
F. H. Boulger
R. C. Buehl
Dennis Carney
Gerhard Derge
L. G. Ekholm
J. F. Elliott
Ralph Farley
S. Feigenbaum
D. J. Girardi
N. J. Grant
D. C. Hilty
J. M. Kirkpatrick
Shadburn Marshall
D. L. McBride
E. F. Osborne
R. Schuhmann
C. W. Sherman
T. B. Winkler

BLAST FURNACE, COKE OVEN AND RAW MATERIALS COMMITTEE

Samuel Naismith, Chairman
Kurst Neustaetter, Vice-Chairman
C. C. Russell, Vice-Chairman
R. E. Powers, Secretary
Ernest Kirkendall, Treasurer

EXECUTIVE BOARD

F. V. Devaney
E. J. Duffy
E. J. Gardner
C. G. Hogberg
E. H. Rose
L. Tefft

COMMITTEES

PROGRAM

W. E. Marshall, Chairman

J. E. Eberhardt
F. M. Hamilton
H. W. Jackman
R. P. Liggett
J. D. Sensesman
C. M. Squarey

FINANCE

R. S. Carey, Chairman

Britt Day
H. G. Macey
V. J. Nolan
H. A. White
J. S. Wilbur

MEMBERSHIP

E. J. Andberg, Chairman

COAL DIVISION

Established as a Division
September 20, 1929

A. Lee Barrett, Chairman
Ralph E. Kirk, Chairman-elect
David R. Mitchell, Secretary-Treasurer
Professor of Mining
The Pennsylvania State College
State College, Pa.

COMMITTEES

EXECUTIVE

The Executive Committee consists of the Officers, Chairmen of Committees, and nine elected members as follows:

Until February 1953
Henry A. Dierks
Claude P. Heiner
Richard H. Swallow

Until February 1954
S. M. Cassidy
Nelson L. Davis
J. T. Ryan, Jr.

Until February 1955
Frank W. Earnest, Jr.
Garold R. Spindler
Elmer R. Kaiser

MINING

J. W. Woomer, Chairman

SUBCOMMITTEES

ANTHRACITE MINING METHODS

John W. Buch, Chairman

Andrew Allan, Jr. — Earl W. Lamb
George J. Clark — Harry W. Montz
David Crawford — Walter B. Petzold
John M. Humphrey, Jr. — E. T. Powell

BITUMINOUS MINING METHODS

D. L. McElroy, Chairman

A. W. Asman — James C. Gray
A. J. Breitenstein — Wm. J. Jenkins
Samuel M. Cassidy — R. G. Lassell
J. F. Core — James Dunn Reilly
D. H. Dowlin — George M. Rigg
Erwin Gammeter — Edward Thomas
Amzi G. Gossard — Harry A. Treadwell

ANTHRACITE OPEN-PIT MINING METHODS

Willis C. Schlaseman, Chairman

Charles T. Butler — William P. Geise
Francis Chesney — A. F. Hutcheson
F. Edgar Kudlich

BITUMINOUS OPEN-PIT MINING METHODS

T. C. Cheasley, Chairman

William L. Burt — Walter B. Roe
Alfred E. Flowers — Richard H. Swallow

SAFETY AND VENTILATION

C. M. Donahue, Chairman

George T. Gillison — Raymond Mancha
Donald C. Jones — Frank J. Peternell
Stephen Krickovic — Carl A. Peterson
George E. McElroy — Cloyd M. Smith

MAINTENANCE

Victor D. Hanson, Chairman

A. W. Bitner — C. D. Rubert
Kenneth E. Caine — Woods G. Talman
W. M. Calder — F. R. Zachar
Ralph M. Hunter

PREPARATION

Raymond E. Zimmerman, Chairman

SUBCOMMITTEES

DEWATERING AND DRYING METHODS

Wm. T. Turrall, Chairman

H. Wm. Ahrenholz, Jr. — George W. Jones
James Blair — James J. Merle
F. P. Calhoun — V. F. Parry
D. A. Dahlstrom — F. M. Stephens, Jr.
Laning Dress — Russell H. Wilmot

FINE COAL CLEANING

John Griffen, Chairman

William M. Bertholf — B. W. Gandrud
George H. Chapman — Donald N. Griffin
H. B. Charmbury — H. R. Hagen
W. L. Dennen — James Hannigan
Gerard C. Gambs — George H. Kennedy

COARSE COAL CLEANING

Jacques M. Vonfeld, Chairman

H. B. Charmbury — J. D. Martin
Nelson L. Davis — W. L. McMorris, Jr.
A. W. Gaber — H. R. Randall
T. W. Guy — Howard R. Stelzriede
R. E. Joslin — G. B. Walker

UTILIZATION

J. F. Barkley, Chairman

SUBCOMMITTEES

COMBUSTION

Charles H. Sawyer, Chairman

Eugene D. Benton — Howard A. Herder
Carroll F. Hardy — Raymond C. Johnson
Wilbur C. Helt — Theodore S. Spicer
Robert L. Sutherland

CARBONIZATION

Carl E. Lesher, Chairman

Robert W. Campbell — Frank H. Reed
Joseph D. Davis — Charles C. Russell
E. J. Gardner

GASIFICATION

C. C. Wright, Chairman

Thomas C. Cheasley — John Mitchell
George D. Creelman — L. D. Schmidt

HYDROGENATION

J. D. Doherty, Chairman

E. V. Murphree — A. R. Powell
Joseph Pursglove, Jr.

NON-FUEL USES

R. C. Johnson, Chairman

H. B. Charmbury — E. R. Kaiser
C. A. Reed

AIR POLLUTION

H. F. Hebley, Chairman

R. E. Doherty — L. C. McCabe
E. E. Finn — H. P. Munger
W. A. Schmidt

PROGRAM

Ralph B. Textor, Chairman

John F. Barkley — J. W. Woomer
M. D. Cooper — Raymond E. Zimmerman

PUBLICATIONS

H. P. Greenwald, Chairman

D. H. Davis — H. J. Rose
Carroll F. Hardy — G. A. Shoemaker
Raymond C. Johnson — J. A. Younkins, Jr.

MEMBERSHIP

Gerald R. Spindler, Chairman

Arthur Bradbury, Harry G. Kennedy, M. D. Cooper, H. E. Mauck, Nelson L. Davis, D. R. Schooler, J. H. Fulford, James W. Stewart, John T. Griffiths, W. L. Wearly, Charles T. Holland, Harold B. Wickey, Albert M. Keenan, H. F. Yancey

STUDENT INTEREST AND WELFARE

M. D. Cooper, Chairman

L. I. Cothern, D. L. McElroy, Cadwallader Evans, Jr., E. R. Price, R. T. Gallagher, G. R. Spindler, Charles T. Holland, J. W. Stewart, Richard Maize, H. L. Walker

NOMINATING

Carroll F. Hardy, Chairman

Carroll A. Garner, D. R. Mitchell

PERCY NICHOLLS AWARD

A. W. Thorson, Chairman, '52
Thomas Cheasley, '54
J. B. Morrow, '53
Thomas A. Marsh, '56
E. R. Price, '55

COAL ECONOMICS

R. M. Fleming, Chairman

R. L. Anderson, K. L. Marshall, R. P. Bremmer, J. W. Morgan, H. V. Brown, R. G. Pfahler, John Buch, C. A. Peterson, Gerald C. Gambs, John P. Weir, G. B. Gould, H. B. Wickey

JOINT MEETING

Elmer R. Kaiser, '52 (AIME), Chairman
George E. Keller, '54 (AIME)
W. E. Reaser, '55 (ASME)
A. W. Thorson, '53 (ASME)

MINERAL INDUSTRY EDUCATION DIVISION

Established as a Division January 15, 1932

Harry H. Power, Chairman
J. R. Van Pelt, Vice-Chairman
J. Donald Forrester, Secretary-Treasurer
Missouri School of Mines and Metallurgy, Rolla, Mo.

COMMITTEES

EXECUTIVE

Until February 1953	Until February 1954
J. Donald Forrester	Robert M. Brick
John P. Spielman	George B. Clark
J. W. Stewart	Edward H. Wisser

Unitl February 1955
C. J. Christensen
C. S. Crouse
E. M. Thomas
Allison Butts, Past Chairman

COLLEGE ENROLLMENT STATISTICS

W. B. Plank, Chairman

EMPLOYMENT CONDITIONS FOR MINERAL ENGINEERS

Carl J. Christensen, Chairman
Kenneth H. Donaldson
J. George Grunenfelder
William E. Milligan
H. Vance White

GEOLOGY COURSES

J. W. Vanderwilt, Chairman

Robert Wesley Brown, Edward Sampson, H. Richard Gault, Justin Zinn

GEOPHYSICS COURSES

H. W. Straley, III, Chairman

Everett F. Stratton, F. W. Van Tuyl, R. Maurice Tripp, George P. Woollard

GRADUATE STUDY

Harold L. Walker, Chairman

George J. Barker, N. H. Manderfield, Philip B. Bucky, Albert B. Stevens

INDUSTRIAL MINERALS AND CERAMICS COURSES

C. S. Crouse, Chairman

A. F. Greaves-Walker, Allan M. Short, D. W. McGlashan

LATIN-AMERICAN EDUCATION RELATIONS

Edward Steidle, Chairman
J. C. Fox
L. C. Schroller
E. M. Thomas
C. Will Wright

MEMBERSHIP

Eugene M. Thomas, Chairman
The Faculty Sponsors of Student Chapters

METALLURGY COURSES

E. A. Peretti, Chairman
Peter E. Kyle
Alvin J. Thompson
John P. Nielson
Gerald Van Dusee

MINERAL DRESSING COURSES

O. Cutler Shepard, Chairman
S. R. B. Cooke
H. Gordon Poole
Edward Martinez
R. E. Zimmerman

MINERAL ECONOMICS EDUCATION

Roland D. Parks, Chairman
A. Irving Levorsen
Paul M. Tyler
A. K. Snelgrove
S. T. Yuster

MINING COURSES

J. W. Stewart, Chairman
George T. Bator
George B. Clark
Stefan Boshkov
M. D. Cooper

PETROLEUM ENGINEERING COURSES

John C. Calhoun, Chairman
W. F. Cloud
Jack L. Landermilk
Charles R. Dodson
Charles F. Weinaug

NOMINATIONS

Allison Butts, Chairman
Curtis L. Wilson
A. F. Greaves-Walker
J. R. Cudworth
E. A. Holbrook

PROGRAMS AND MEETINGS

Carl J. Christensen, Chairman
Sam T. Yuster
Vernon Scheid
E. M. Thomas

PUBLICATIONS

John P. Nielsen, Chairman
J. Donald Forrester
W. B. Plank
H. R. Gault
W. J. Rundle

INDUSTRIAL MINERALS DIVISION

(Nonmetallics)

Established as a Division March 15, 1935

Ian Campbell, Chairman
Robert C. Stephenson, Eastern Vice-Chairman
Allen Cole, Southeastern Vice-Chairman
David P. Hale, Jr., Rocky Mountain Vice-Chairman
G. H. Waterman, Western Vice-Chairman
M. F. Goudge, Canadian Vice-Chairman
James Norton, Secretary-Treasurer
Mineral Deposits Branch
U. S. Geological Survey
Washington 25, D. C.

COMMITTEES

EXECUTIVE

Until February 1953	Until February 1954
R. M. Foose	James A. Barr, Sr.
J. L. Gillson	A. B. Cummins
R. H. Jahns	G. Richards Gwinn

Until February 1955
H. M. Bannerman
W. D. Holland
G. W. Josephson

PAPERS AND PROGRAM

George D. Dub, Chairman
Sandford S. Cole, Vice-Chairman
J. E. Allen
Will Mitchell, Jr.
J. G. Broughton
T. D. Murphy
C. F. Deiss
L. A. Norman
J. F. Havard
J. A. Pask
R. H. Jahns
R. C. Stephenson
M. L. Leonardi
R. G. Vervaecke
M. J. Messel
R. H. Wightman

AUXILIARY PUBLICATIONS
Bruce C. Netschert, Chairman
H. M. Bannerman
J. A. Barr, Sr.
H. I. Smith
R. W. Smith

NOMINATING
A. B. Cummins, Chairman
R. M. Foose
J. L. Gillson
H. A. Meyerhoff
R. W. Smith

MEMBERSHIP
A. O. Bartell, Chairman
James A. Barr, Sr., Vice-Chairman
W. Aitkenhead
J. H. Jensen
Vernon Scheid
J. P. Smith
Ralph Watson

1952 FALL MEETING
R. C. Stephenson, Chairman
J. A. Barr, Jr.
C. F. Clausen
S. F. Cole
C. F. Deiss
G. D. Dub
J. F. Havard
M. M. Leighton

MINERAL AGGREGATES
Thomas D. Murphy, Chairman
Robert S. Barneyback, Vice-Chairman
R. E. Brooke
E. W. Bauman
P. G. Forman
R. C. Mielenz
N. T. Severinghaus

MILLING METHODS
Will Mitchell, Jr., Chairman
Walter E. Duncan, Vice-Chairman
R. B. Adair
W. T. Bishop
R. B. Booth
S. H. Ingram
V. L. Mattson
R. G. Vervaeke

MINERAL ECONOMICS
L. A. Norman, Jr., Chairman
W. F. Dietrich, Vice-Chairman
C. P. Dunbar
S. H. Ingram
T. D. Murphy
L. C. Richards

MINING GEOLOGY
John E. Allen, Chairman
T. L. Kesler, Vice-Chairman
T. H. Kuhn
J. E. Lamar
J. T. Lonsdale
R. S. Mason
R. S. McClellan
W. F. Pond
K. E. Rose
L. A. Wright

MINING METHODS
Randall H. Wightman, Chairman
H. W. Ahrenholz, Vice-Chairman
F. I. Bristol
R. T. Gallagher
G. F. Jenkins
R. R. Knill
C. B. Mould
Bernard York

CEMENT, LIME & GYPSUM
John F. Havard, Chairman
Orville E. Jack, Vice-Chairman
C. F. Clausen
A. I. Edwards
Bror Nordberg
H. L. Waldthausen
Irving Warner
C. C. Van Zandt

CERAMIC MATERIALS
Joseph A. Pask, Chairman
Lane Mitchell, Vice-Chairman
G. J. Biddle
A. L. Harris
J. C. Hicks
J. C. Sullivan
Louis Moyd
Mrs. Louis Moyd
L. A. Wright

CHEMICAL RAW MATERIALS
M. L. Leonardi, Chairman
O. M. Wicken, Vice-Chairman
J. F. Bell
G. D. Dub
J. D. Gordon, Jr.
R. M. Grogan
H. R. Mosley
J. P. Perry
F. D. Shay
W. C. Weber

DIMENSION STONE & SLATE
Charles F. Deiss, Chairman
J. B. Lord, Vice-Chairman
O. Bowles
R. A. Fletcher
G. W. Josephson
W. F. Mullen
G. M. Schwartz

FILLERS, FIBERS & PIGMENTS
Michael J. Messel, Chairman
Delmar H. Larsen, Vice-Chairman
C. Borror
O. Bowles
R. B. Ladoo
K. C. Laylander
W. B. Millar
G. G. Schuknecht

RARE MINERALS
Richard H. Jahns, Chairman
Gordon H. Chambers, Vice-Chairman
J. B. Hanley
C. E. Hunter
A. Montgomery
Stephen Shelton
H. S. Spence

BYLAWS AND ORGANIZATION
Richard J. Lund, Chairman
J. V. Beall
Oliver Bowles
Ian Campbell
R. M. Foose
J. L. Gillson
H. I. Smith

MINERALS BENEFICIATION DIVISION

Established as a Division February 16, 1948

E. H. Crabtree, Jr., Chairman
Donald W. Scott, Associate Chairman
S. D. Michaelson, Regional Vice-Chairman
Will Mitchell, Jr., Regional Vice-Chairman
William B. Stephenson, Secretary-Treasurer
Allen-Sherman-Hoff Pump Co.
259 Lancaster Avenue
Wynnewood, Pa.
Raymond E. Byler, Past Chairman

COMMITTEES

NOMINATING

E. H. Rose, Chairman
Raymond E. Byler — Grover J. Holt
E. W. Engelmann — J. F. Myers
S. J. Swainson

EDUCATION

H. Rush Spedden, Chairman
S. R. B. Cooke — Frank R. Milliken
Fred D. DeVaney — A. W. Schlechten
F. M. Lewis — William T. Turrall
G. V. Woody

MEMBERSHIP

J. P. Bonardi, Chairman
S. R. B. Cooke, Vice-Chairman
Stuart A. Falconer, Vice-Chairman
Nicholas H. Manderfield, Vice-Chairman
D. N. Vedensky, Vice-Chairman
Nathaniel Arbiter — A. W. Fahrenwald
Jay A. Carpenter — Harold T. Herivel
Melvin A. Cook — James H. Jacobs
J. B. Cunningham — Vernon L. Mattson
Joseph Daniels — David R. Mitchell
George M. Darby — David W. Mitchell
Stephen E. Erickson — Thomas M. Morris
Oscar F. Tangel

PAPERS AND PUBLICATIONS

M. D. Hassialis, Chairman
S. R. B. Cooke — S. D. Michaelson
F. M. Lewis — T. M. Morris
Frank W. McQuiston — H. Rush Spedden

PROGRAM

Donald W. Scott, Chairman
Nathaniel Arbiter — Neil Plummer
Wayne Dowdey — Robert Powers
James E. Lawver — Francis Tartaron
Frank Milliken — Norman Weiss

SYMPOSIUM

Francis Tartaron, Chairman
Fred DeVaney, Vice-Chairman
Tom Ban — S. E. Erickson

CONCENTRATION

Norman Weiss, Chairman
P. H. Ensign, Vice-Chairman
Paris V. Brough — J. R. Clarkson
W. R. Van Slyke

CRUSHING AND GRINDING

Neil Plummer, Chairman
David P. Hale, Jr., Vice-Chairman
F. E. Briber, Jr. — W. H. Keener
H. K. Martin

MATERIALS HANDLING

Frank Milliken, Chairman
Walter Snavely, Vice-Chairman
R. M. P. Hamilton — Neil Plummer
Ralph B. Utt

OPERATING CONTROL

James E. Lawver, Chairman
E. W. Gieseke, Vice-Chairman
Robert Berg — Felix J. Lossen, Jr.
Arthur P. Wichmann

PYROLYSIS & AGGLOMERATION

Robert E. Powers, Chairman
J. L. Lake, Vice-Chairman
A. F. Hillcke — K. C. McCutcheon
A. A. Nilsen

SOLIDS-FLUIDS SEPARATION

Wayne L. Dowdey, Chairman
Frank Weems, Vice-Chairman
Orville Lyons — G. Sherrerd, Jr.
Ray Thompson

SOLUTION AND PRECIPITATION

Nathaniel Arbiter, Chairman
Fred Frick, Vice-Chairman
Sam Korman — B. H. McLeod
Oscar Tangel

EXTRACTIVE METALLURGY DIVISION

Established as a Division November 17, 1948

T. D. Jones, Chairman
O. C. Ralston, Past Chairman
R. R. McNaughton, Chairman-elect
B. W. Gonser '53, Vice-Chairman
P. T. Stroup '54, Vice-Chairman
Ernest Kirkendall, Secretary
29 West 39th Street, New York City

COMMITTEES

EXECUTIVE

1953
R. B. Caples
A. C. Loonam
1954
R. D. Bradford
L. P. Davidson
1955
J. C. Kinnear, Jr.
J. D. Sullivan

MEMBERSHIP

R. D. Bradford, Chairman
H. L. Johnson, Secretary

E. A. Barnard, R. R. McNaughton, E. H. Bunce, M. M. Neale, P. C. Feddersen, A. W. Schlechten, K. Harms, F. P. Sinn, J. C. Kinnear, Jr., J. D. Sullivan, C. R. Kuzell, R. A. Young, C. C. Long, S. R. Zimmerley

NOMINATING

C. C. Long, Chairman

R. B. Caples, A. W. Schlechten, R. R. McNaughton, J. D. Sullivan

PAPERS AND PROGRAM

P. T. Stroup, Chairman

L. P. Davidson, J. C. Kinnear, Jr., P. R. Drummond, J. G. Leckie, B. W. Gonser, H. W. St. Clair, H. H. Kellogg, H. A. Tobelmann, F. E. Wormser

TECHNICAL PUBLICATIONS

J. Glasser, Chairman

R. R. McNaughton, S. F. Ravitz, J. D. Sullivan

ALUMINUM AND MAGNESIUM

H. W. St. Clair, Chairman

D. N. Beetem, C. P. Love, D. L. Colwell, L. M. Pidgeon, F. J. Krenzke, R. S. Sherwin, P. T. Stroup

REDUCTION AND REFINING OF COPPER AND NICKEL

J. G. Leckie, Chairman

R. R. Burns, E. R. Marble, E. W. Donahue, R. H. Miller, M. G. Fowler, D. L. Ogden, W. H. Goodrich, R. D. Parker, K. Harms, W. G. Rouillard, L. W. Kemp, H. A. Shaw, E. R. Lovell, J. H. Schloen

ECONOMICS AND STATISTICS

Felix Wormser, Chairman

E. V. Gent, J. D. MacKenzie, F. H. Hayes, P. D. Merica, J. L. Head, D. A. Rhoades, D. M. Liddell, C. N. Schuette, G. M. Wiles

ELECTROLYTIC EXTRACTIVE PROCESSES

P. R. Drummond, Chairman
T. H. Weldon, Vice-Chairman

H. E. Bakken, S. Mellgren, E. S. Bardwell, W. L. Miles, Jr., T. K. Graham, A. J. Phillips, H. R. Hanley, S. Skowronski, C. L. Mantell, R. H. Waddington, W. G. Woolf

HYDROMETALLURGY

H. A. Tobelmann, Chairman

J. A. Barr, N. Herz, C. H. Benedict, H. C. Kenny

R. E. Byler
T. G. Chapman
J. B. Clemmer
B. H. Cody
T. B. Counselman
L. P. Davidson
Frank Forward
H. E. Keyes
F. W. McQuiston
C. Kettering
J. D. Sullivan
A. L. Ter Braake
Jean Verduseen
W. G. Woolf
K. K. Kelley
A. J. Phillips
L. M. Pidgeon
Wm. Roe
R. Schumann, Jr.
F. Stephens, Jr.
P. T. Stroup
S. F. Urban

LEAD AND ZINC

L. P. Davidson, Chairman
W. T. Isbell, Vice-Chairman

E. H. Bunce
R. B. Caples
P. C. Feddersen
R. L. Hallows
H. R. Hanley
A. C. Jephson
H. L. Johnson
R. G. Knickerbocker
Y. E. Lebedeff
A. E. Lee, Jr.
C. C. Long
R. R. McNaughton
B. L. Sackett
E. McL. Tittmann
W. G. Woolf
R. A. Young

PHYSICAL CHEMISTRY OF EXTRACTIVE METALLURGY

H. H. Kellogg, Chairman
N. Arbiter, Vice-Chairman

PYROMETALLURGY

J. C. Kinnear, Jr., Chairman

R. D. Bradford
R. B. Caples
P. C. Feddersen
P. D. I. Honeyman
R. G. Knickerbocker
L. L. McDaniel
R. R. McNaughton
S. M. Shelton
E. A. Slover
E. McL. Tittmann

TITANIUM AND UNCOMMON METALS

B. W. Gonser, Chairman

W. J. Barth
Ira Hearn
A. R. Kaufmann
W. J. Kroll
F. B. Litton
Wm. Opie
M. J. Udy
F. S. Wartman

MINERAL ECONOMICS DIVISION

Established as a Division December 15, 1948

Evan Just, Chairman
Richard J. Lund, Past Chairman
Granville S. Borden, Vice-Chairman
J. K. Richardson, Vice-Chairman
S. H. Williston, Vice-Chairman
Allan Matthews, Secretary-Treasurer
National Security Resources Board
17th and Pennsylvania Ave., N.W.
Washington 25, D. C.

EXECUTIVE COMMITTEE

Until Feb. 1953
R. J. Bradley
W. W. Mein, Jr.
Simon D. Strauss

Until Feb. 1954
Russell H. Bennett
G. W. Josephson
S. G. Lasky

Until Feb. 1955
Gilbert H. Cady
Roland D. Parks

COMMITTEE CHAIRMEN

James K. Richardson, *Papers and Programs*
Roland D. Parks, *Membership*
Richard J. Lund, *Nominating*
Herbert A. Franke, *Auxiliary Publications*

MINING, GEOLOGY, AND GEOPHYSICS DIVISION

Established as a Division September 27, 1949

LeRoy Scharon, Chairman
C. M. Cooley, Secretary
29 West 39th Street
New York 18, N. Y.

EXECUTIVE COMMITTEE

E. D. Gardner, Chairman
John S. Brown
Theodore Koulomzine
V. H. Clarke
W. C. Lawson
J. D. Forrester
Le Roy Scharon

NOMINATING COMMITTEE

E. D. Gardner, Chairman
D. M. Davidson
Sherwin F. Kelly
H. Hoover, Jr.
J. M. Riddell
P. Shenon

MINING SUBDIVISION

E. D. Gardner, Chairman
Tell Ertl, Secretary

COMMITTEES

EXECUTVE

E. D. Gardner, Chairman
V. H. Clarke
Tell Ertl
W. C. Lawson

ALLUVIAL MINING

Charles M. Romanowitz, Chairman
Norman Cleaveland
W. H. S. McFarland
Arthur F. Daily
Charles Merrill
Vance R. Fenton
Ernest N. Patty
R. E. Franklin
Jay P. Wood

OPEN CUT MINING

J. Murray Riddell, Chairman
R. M. Belliveau
E. A. Friedman
B. R. Coil
W. H. Goodrich
J. P. Courtright
C. E. McManus
R. M. Dickey
L. F. Pett
E. J. Fearing
L. J. Severson
D. S. Young

BLOCK CAVING

R. H. Wightman, Chairman
John F. Buchanan
F. S. McNicholas
Martin K. Hannifan
Gerald Sherman
Robert W. Hughes
H. Carroll Weed
K. V. Lindell

LONG-HOLE DRILLING AND SUB-LEVEL CAVING

Lamar Weaver, Chairman
Albert Mendelsohn

TOP SLICING

E. P. Pfleider, Chairman
C. W. Allen
Lucien Eaton
A. T. Anderson
J. J. Foucault
R. W. Braund
E. M. Norris

ROOM AND PILLAR OR STOPE AND PILLAR

S. S. Clarke, Chairman
S. S. Arentz, Jr.
C. O. Dale
C. K. Bain
C. A. R. Lambly
J. T. Cole
M. J. Langley
R. J. Linney

SHRINKAGE AND SQUARE-SET STOPING

J. B. Haffner, Chairman
A. G. Bigley
C. H. Johnson
T. P. Billings
J. C. Kieffer
J. P. Caulfield
W. S. Row
W. P. Crawford
T. Alfred Snedden
W. P. Goss
T. M. Waterland

CUT AND FILL MINING

Herman J. Mutz, Chairman
John Edgar
J. D. McAuliffe
W. A. Knoll
N. A. O'Donnell
H. E. Krumlauf
S. E. Quayle
W. N. Matheson, Jr.
E. G. Ross

HOISTING

Harlan A. Walker, Chairman
J. P. Caulfield
F. C. Jaccard
Darrell Gardner
H. J. Mutz
R. E. Hobart, Sr.
Russell Sage

HAULAGE

Charles A. R. Lambly, Chairman
J. R. Giegerich
S. W. McDougall
L. M. Kinney
R. T. Murrill
Fred Stewart

MECHANICAL LOADING AND CONVEYING

Lewis E. Young, Chairman

C. K. Bain
A. W. Beck, Jr.
J. W. Buch
S. S. Clarke
M. H. Fies
E. H. Miller
R. D. Satterley
C. W. Thompson

DRAINAGE

Gloyd M. Wiles, Chairman

O. W. Bilharz
W. P. Goss
J. C. Kinnear, Jr.
W. E. Romig
F. H. Stewart

DRILLING AND BLASTING

E. R. Borcherdt, Chairman

Vinton H. Clarke
George L. Craig
K. V. Lindell
H. Carroll Weed

EXPLORATION DRILLING

Robert D. Longyear, Chairman

B. R. Coil
J. J. Collins
Frank Ebbutt
C. H. Johnson
P. J. Shenon
F. C. Sturges

SUBSIDENCE AND MECHANICS OF ROCK STRUCTURE

Philip B. Bucky, Chairman

B. R. Coil
H. C. Livingston
H. J. Mutz
Leonard Obert
Stephen Royce
L. M. Scofield

AUXILIARY PUBLICATIONS

Ross D. Leisk, Chairman

M. C. Brown
John Edgar
Rollin Farmin
G. T. Harley
R. S. Hooper
R. W. Hughes

PAPERS AND PROGRAM

Tell Ertl, Chairman

Frank Coolbaugh
E. A. Jones
P. Joralemon
L. M. Kinney
L. T. Postle
C. L. Richards
Maynard Van Ornum
H. C. Weed

MEMBERSHIP

Leland A. Walker, Chairman

John J. Curzon
P. R. Bradley, Jr.

GEOLOGY SUBDIVISION

J. D. Forrester, Chairman
John S. Melvin, Secretary

COMMITTEES

EXECUTIVE

J. Donald Forrester, Chairman
John H. Melvin, Secretary

John S. Brown
Ralph Tuck

AUXILIARY PUBLICATIONS

Edward Wisser, Chairman

A. L. Anderson
R. H. McConnell
Charles Meyer
James A. Noble

PAPERS AND PROGRAM

Edward L. Clark, Chairman

Roy P. Full
Olaf Jenkins
Vincent D. Perry
Harold A. Powers
Vernon E. Scheid
A. K. Snelgrove
J. R. Van Pelt

MEMBERSHIP

Clayton G. Ball, Chairman

Carl Tolman
F. S. Turneaure

GEOPHYSICS SUBDIVISION

LeRoy Scharon, Chairman
Florence Robertson, Secretary
St. Louis University
3621 Olive St., St. Louis 8, Mo.

COMMITTEES

EXECUTIVE

LeRoy Scharon, Chairman

Sherwin Kelly
Theodore Koulomzine
Florence Roberston

PAPERS AND PROGRAM

Theodore Koulomzine
Basil Wilson
E. W. Westrick
H. V. Warren

AUXILIARY PUBLICATIONS

Florence Robertson, Chairman

R. R. Heinrich
LeRoy Scharon

MEMBERSHIP

Homer Jensen, Chairman

George Adair
Sherwin F. Kelly

NOMINATING

Sherwin F. Kelly, Chairman

Paul Bird
D. Wantland

OFFICERS AND COMMITTEES OF LOCAL SECTIONS

COUNCIL OF SECTION DELEGATES

Jack A. Crichton, Chairman
Allen T. Cole, Vice-Chairman
M. I. Signer, Secretary

EXECUTIVE COMMITTEE

W. C. Leonard, *North Pacific*
W. K. Bock, *Cleveland*
W. W. Leonard, *Southwest Texas*

DELEGATES

Alaska—Robert M. Chapman
Arizona—J. B. Cunningham
Black Hills—James O. Harder
Boston—R. Schumann, Jr.
Carlsbad Potash—E. W. Douglass
Central Appalachian—Charles T. Holland
Chicago—H. A. White
Cleveland—W. K. Bock
Colorado—M. I. Signer
Columbia—Lewis A. Grant
Connecticut—Lewis E. Thelin
Delta—Raymond B. Kelly, Jr.
Detroit—Frederick P. Bens
East Texas—W. W. Leonard
El Paso Metals—Eugene M. Thomas
Florida—Allen T. Cole
Gulf Coast—H. E. Treichler, Jr.
Kansas—G. L. Yates
Lehigh Valley—R. T. Gallagher
Mid Continent—J. N. McGirl
Minnesota—Eugene P. Pfleider
Montana—F. W. Strandberg
Nevada—J. C. Kinnear, Jr.
New York—Philip D. Wilson
North Pacific—W. C. Leonard
North Texas—Jack A. Crichton
Ohio Valley—John H. Melvin
Oklahoma City—J. H. Field
Oregon—D. H. Beetem
Penn. Anthracite—Henry Dierks
Permian Basin—Jack M. Moore
Philadelphia—A. A. Bradd
Pittsburgh—Linwood Thiessen
San Francisco—Walter L. Penick
St. Louis—Clyde S. Smith
Southeast—E. H. Rose
Southern California—Basil Kantzer
Southwest Texas—Harry D. Vaughan
Southwestern Alaska
Southwestern New Mexico—J. W. Faust
Tri-State—J. C. Stipe
Upper Peninsula—Roy W. Drier
Utah—Whitman G. Rouillard
Washington, D. C.—Paul M. Tyler
Wyoming—Henry G. Fisk

ALASKA

Established November 19, 1947
Regular meetings fourth Monday of each month except June, July, and August

Donald J. Cook, Chairman
Robert M. Chapman, Vice-Chairman
Robert E. Shafer, Secretary-Treasurer
Box 1170
Fairbanks, Alaska
Robert M. Chapman, Section Delegate

COMMITTEES

MEMBERSHIP

Douglas B. Colp, Chairman
Earl Beistline L. M. Anthony

LIBRARY

Bond Tabor, Chairman
Robert Saunders Eugene Davis

ARIZONA

Established July 10, 1915

Wesley P. Goss, Chairman
Lyle M. Barker, First Vice-Chairman
J. A. Richards, Second Vice-Chairman
John F. Buchanan, Secretary-Treasurer
Magma Copper Co.
Superior, Arizona
J. B. Cunningham, Section Delegate

Directors

A. T. Barr H. F. Mills
T. G. Chapman A. P. Morris
B. R. Coil J. B. Pullen
E. R. Dickie F. V. Richard
G. J. Duff G. H. Ruggles
D. Gardner H. C. Weed
W. C. Lawson J. A. Wilcox
C. E. Mills C. F. Willis
D. Brittain

Past Chairmen
A. Mendelsohn P. D. I. Honeyman
C. R. Kuzell

Morenci Subsection
J. Urban Larson, Chairman
Richard T. Moolick, Program Chairman
Robert E. Mann, Secretary-Treasurer

Ajo Subsection
J. W. Byrkit, Chairman
Orazio Fenzi, Vice-Chairman
F. W. Denny, Secretary-Treasurer

TECHNICAL DIVISIONS
I.—Mining Geology
C. A. Anderson, Chairman
S. S. Williams, Secretary
II.—Underground Mining
A. B. Robb, Chairman
III.—Open Pit Mining
J. R. Watts, Chairman
J. L. Carne, Secretary
IV.—Ore Dressing
E. G. Lewis, Chairman
V.—Smelting
F. H. Day, Chairman
J. B. Cunningham, Secretary

BLACK HILLS

Established December 18, 1936

John W. Mitchell, Chairman
Sidney M. Runke, First Vice-Chairman
A. L. Slaughter, Second Vice-Chairman
Arthur J. Rice, Secretary-Treasurer
P. O. Box 380
Lead, So. Dakota
James O. Harder, Section Delegate
John W. Mitchell, Alternate

COMMITTEES

EXECUTIVE
Above Officers and
E. H. Stevens Gerald A. Munson
William C. Campbell James O. Harder

MEMBERSHIP
Gerald Van Dusee, Chairman
Frank M. Howell A. I. Johnson
David M. Middleton

STUDENT AFFAIRS
Elmer R. Drevdahl, Chairman
John Gries Fremont Clark

BOSTON

Established September 20, 1911
Meets First Monday of each month
October to May inclusive

Roland D. Parks, Chairman
Peter Kosting, Vice-Chairman
R. Schumann, Secretary-Treasurer
Massachusetts Institute of Technology
Cambridge 39, Mass.
R. Schumann, Section Delegate

EXECUTIVE COMMITTEE
A. M. Gaudin R. Schumann, Jr.
Roland T. Parks Harrison I. Dixon
John Wulff

H. Rush Spedden, Student Adviser
A. M. Gaudin, Chairman,
Membership Committee

CARLSBAD POTASH

Established September 19, 1946
Meets third Thursday of each month
except July and August

G. C. Weaver, Chairman
W. P. Wilson, First Vice-Chairman
H. P. Clark, Second Vice-Chairman
H. N. Clark, Secretary-Treasurer
Box 31, Carlsbad, New Mexico
E. W. Douglass, Section Delegate
W. P. Wilson, Alternate

Committee Chairmen
D. S. Libbey, Entertainment
H. P. Clark, Membership

CENTRAL APPALACHIAN

Established October 17, 1940

Fred K. Prosser, Chairman
George R. Higinbotham, Vice-Chairman
C. H. Hodgson, Vice-Chairman
G. R. Spindler, Vice-Chairman
Charles T. Holland, Secretary-Treasurer
P. O. Box 836, Blacksburg, Va.
Charles T. Holland, Section Delegate

EXECUTIVE COMMITTEE
Rhesa M. Allen
James B. Benson
C. R. Bourlund
L. I. Cothern
George E. Keller
John T. Parker
H. O. Zimmerman

CHICAGO

Established February 26, 1914
Holds dinner meeting first Wednesday
of each month, October to May inclusive,
at the Chicago Bar Association

W. E. Mahin, Chairman
C. M. Squarcy, Secretary-Treasurer
Inland Steel Co.
East Chicago, Indiana
H. A. White, Section Delegate

PAST CHAIRMEN

H. A. Herder — H. A. White
T. S. Washburn — H. W. Johnson
Roy A. Lindgren

COMMITTEE CHAIRMEN

James Halley, Program
Dennis Carney, Membership
C. H. Samans, Service Representative
W. P. Ruemmler, Publicity
H. M. St. John, Student Relations
W. John King, Student Relations
Wm. Schweickhardt, Reception

JUNIOR ENGINEER REPRESENTATION

Fred G. Jaicks

INTER-SOCIETY REPRESENTATIVES

R. E. Laub — G. M. White

INTER-SOCIETY ALTERNATES

A. Forrest — F. L. Warner

MEMBERS AT LARGE

C. G. Ball — P. R. Nichols
L. R. Berner — M. E. Nickel
A. J. Cochrane — M. Tenenbaum
D. L. Colwell — R. Tietig, Jr.
John Hornack — F. J. Tokar

UNIVERSITY REPRESENTATIVES

G. J. Barker, *Wisconsin*
P. A. Beck, *Notre Dame*
G. M. Enos, *Purdue*
H. L. Walker, *Illinois*
O. Zmeskal, *Illinois Tech.*

CLEVELAND

Established April 17, 1936

Milton Tilley, Chairman
Vernon Kalan, Vice-Chairman
James P. Hontas, Secretary
3679 Woodridge Road
Cleveland 21, Ohio
William Baldwin, Jr., Treasurer
W. K. Bock, Section Delegate

EXECUTIVE COMMITTEE

Charles Junge — G. M. Cover
R. Ricksecker

COMMITTEE CHAIRMEN

R. F. Hehemann, Membership
G. M. Cover, Program
E. J. Whittenberger, Publicity

COLORADO

Established May 23, 1913

J. Paul Harrison, Chairman
George R. Harris, Vice-Chairman
Ben H. Parker, Secretary-Treasurer
Boston Building
Denver 2, Colorado
M. I. Signer, Section Delegate

DIRECTORS

C. E. Dobbin — Harvey Matthews
Frank J. Maloit — George Rupp
J. W. Vanderwilt

COMMITTEES

PROGRAM

Lee Scott, Chairman
W. J. Coulter — John Vanderwilt
B. H. Parker — C. L. Barker
W. L. Miles, Jr.

VIOLA VESTAL COULTER FOUNDATION SCHOLARSHIP

Ed Dickerman, Chairman
John Vanderwilt — M. I. Signer

STUDENT SECTION ESSAY AWARD

J. V. Thompson, Chairman
C. B. Carpenter — Franklin Coolbaugh
T. S. Harrison — Max W. Bowen
Judson Hubbard

MEMBERSHIP

A. H. Patten

INTER-MOUNTAIN (CLIMAX) SUBSECTION

B. B. Greenlee, Chairman
F. J. Windolph, Vice-Chairman
E. A. Tyler, Secretary
422 East 9th Street
Leadville, Colorado
R. E. Radabaugh, Treasurer

SAN JUAN SUBSECTION

J. W. George, Chairman
R. D. Van Zante, Vice-Chairman
H. R. Wardwell, Secretary-Treasurer
1560 Main Street
Grand Junction, Colorado

PIKES PEAK SUBSECTION

D. A. Carter, Chairman
P. V. H. Svendsen, Vice-Chairman
B. H. Slothower, Secretary-Treasurer
Golden Cycle Corp.
Cripple Creek, Colorado

COLUMBIA

Established November 24, 1911
Holds meetings first Friday of each month except July and August

W. W. Staley, Chairman
D. L. Myers, Secretary-Treasurer
3427 W. Kiernan
Spokane, Washington
Lewis A. Grant, Section Delegate

COMMITTEE CHAIRMEN
R. A. Watson, Program
J. W. Lowry, Membership

Northwest Industrial Minerals and Metals Branch Conference
Spokane, May 1952
R. G. Vervaeke, Chairman
F. R. Morral, Assistant Chairman, Metals Branch

George Waterman, Assistant Chairman, North Pacific Section

A. O. Bartell, Assistant Chairman, Oregon Section

W. S. Peterson, Program Chairman

COEUR D'ALENE SUBSECTION
J. C. Kieffer, Vice-Chairman
N. J. Sather, Asst. Secretary

SOUTHERN IDAHO SUBSECTION
E. B. Douglas, Vice-Chairman
H. W. Marsh, Asst. Secretary

CONNECTICUT

Established September 30, 1947

Holds meetings second Wednesday, October, December, February and April

David H. Thompson, Chairman
Leon W. Thelin, Vice-Chairman
William E. Milligan, Secretary-Treasurer
Yale University, New Haven, Conn.
Lewis E. Thelin, Section Delegate

COMMITTEE CHAIRMEN
Delmar E. Trout, Publicity
William Mounce, Membership
F. H. Wilson, Member at Large

DELTA

Established September 18, 1946

Holds meetings second Tuesday each month except June, July and August

Raymond B. Kelly, Jr., Chairman
Joseph F. Homer, Vice-Chairman
Joel A. Battle, Jr., Vice-Chairman
Albert L. Vitter, Jr., Secretary
800 California Co. Bldg.
New Orleans, La.
Charles A. Capps, Treasurer
John M. Dillon, Jr., Journal Secretary
Raymond B. Kelly, Jr., Section Delegate

DIRECTORS
Harold F. Winham   E. H. Van Duzee
Murray Hawkins, Jr.
James E. R. Sheeler
Fred E. Simmons, Jr.

COMMITTEES

PUBLICATION
John M. Dillon, Jr., Chairman
Burton W. Aulick

ACTIVITY
Robert S. Sullins, Chairman
B. W. Aulick   H. C. Loehr
A. F. Eggleston   James McLaurin
L. A. J. Monroe

MEMBERSHIP
Alfred H. Glenn, Chairman
W. H. Ashby   F. E. Jones
W. D. Clift   Adam Perez
R. N. Crews   D. A. Schmeeckle

HOUSE
L. D. Jones, Chairman
W. L. Reed   W. G. Snoddy
J. B. Ross   W. B. Vice, Jr.

PROGRAM
E. L. Paramore, Chairman
Russell Lewis   J. L. Shea
J. A. Rorison   R. S. Sullins
C. J. Ward

MISSISSIPPI SUBSECTION
T. Hardy Jackson, Jr., Chairman
John A. Rogers, First Vice-Chairman
J. D. Lowrie, Second Vice-Chairman
Oliver Jones, Secretary-Treasurer
The Pure Oil Co.
Natchez, Miss.

Board of Directors
J. O. Crowe   R. F. Moore
W. McEver   J. B. Tipps
J. K. Wright, Past Chairman

DETROIT

Established February 18, 1936

Holds meetings third Monday of each month except June through September

F. P. Bens, Chairman
H. Moser, Vice-Chairman
E. E. Engle, Secretary
Carboloy Co., Inc.
Detroit, Michigan
B. B. Beckwith, Treasurer
F. P. Bens, Section Delegate

EXECUTIVE COMMITTEE

R. D. Chapman	D. Frey
E. Dofter	N. Lazar
C. Corton	M. Semchyshen
H. Moser	E. Engle
B. B. Beckwith	F. P. Bens
H. Anderson	

PROGRAM COMMITTEE

H. Moser, Chairman

EAST TEXAS

Established April 18, 1940

Holds meetings second Tuesday of each month except July through September

Roland K. Thies, Chairman
A. H. Crawford, Vice-Chairman
Joseph A. Morris, Secretary-Treasurer
Magnolia Petroleum Co.
Box 312
Kilgore, Texas
W. W. Leonard, Section Delegate

DIRECTORS

Harry Pistole	H. L. Long
Rob D. Trimble	J. A. Walker
W. R. Mays	P. J. Lehnhard

COMMITTEE CHAIRMEN

Wayne L. McCann, Program
Gene L. Scheirman, Membership

EL PASO METALS

Established March 25, 1927

Holds meetings second Wednesday of each month

C. S. Harper, Jr., Chairman
B. B. Kunkle, Vice-Chairman
Guy E. Ingersoll, Secretary-Treasurer
Texas Western College
912 W. Yandell Blvd.
El Paso, Texas
Eugene M. Thomas, Section Delegate
Guy E. Ingersoll, Alternate

DIRECTORS

A. A. Collins	H. W. Foester
W. W. Long	J. C. Rintelen, Jr.
P. H. Hale	H. F. Kannady
B. D. Roberts	A. F. Horle

COMMITTEES

MEMBERSHIP

Earle W. Donahue, Chairman
Ernest A. Hase
Leroy G. Hetrick
Carl T. Ivey
Robert J. Benson
Ariel F. Horle

MEETING ARRANGEMENTS

Guy E. Ingersoll **Louis Laurel**

PROGRAM

***February*—Frank J. Christensen**
***March*—J. C. Rintelen, Jr.**
***April*—Ben D. Roberts**
***May*—Mallory L. Miller**
***September*—A. L. Washburn**
***October*—Randolph S. Murray, Jr.**
***November*—Eugene M. Thomas**
***December*—Paul F. Deisler**
***January*—Russell R. Whittington**

RECEPTION

Ralph L. Hennebach, Chairman,

PUBLICITY

H. F. Kannady, Chairman

FLORIDA

Established September 27, 1949

Holds meetings the first Monday of each month

Ernest W. Greene, Chairman
Orrin Hughitt Wright, Vice-Chairman
Walter O. McClintock, Secretary-Treasurer
1170 De Palma Avenue
Bartow, Florida
Allen T. Cole, Section Delegate
Ernest W. Greene, Alternate

COMMITTEE CHAIRMEN

Ernest Greene, Steering
John Yost, Membership
Lawrence Frye, Program

GULF COAST SECTION

Established December 13, 1935

Holds meetings the third Tuesday of each month

George R. Gray, Chairman
R. C. Craze, First Vice-Chairman
A. B. Stevens, Second Vice-Chairman
R. M. Rutledge, Secretary-Treasurer
Lane-Wells Co.
P. O. Box 1407
Houston 1, Texas
H. E. Treichler, Section Delegate

DIRECTORS

C. F. Redman — Herman A. Otto
R. M. Darling — J. R. Welsh
A. W. Waddill

COMMITTEES

JOURNAL CORRESPONDENT
C. L. Singleton

ENGINEERS COUNCIL OF HOUSTON
R. W. Holman
J. S. Levine
Paul Weaver

ACTIVITIES
J. W. Walker, Chairman
T. O. Allen
B. O. Ellington
J. K. Jordan
R. L. Whiting

ARRANGEMENTS
P. W. Cawthon, Chairman
W. B. Colvin
R. W. Hillyer
D. S. Howard
H. A. Koch
R. J. Penrose

MEMBERSHIP
A. S. Trube, Chairman
M. H. Dubrow
R. L. Evans
W. S. Greenwald
Wm. Hurst
C. B. Hussey
A. M. Shook

PROGRAM
W. R. Purcell, Chairman
B. C. Elsley
W. D. Smith, Jr.
E. F. Stratton
Walter Rose
G. G. Wrightsman

KANSAS

Established November 17, 1948

Holds meetings third Wednesday of each month except June through August

L. W. Holsapple, Chairman
G. J. Decker, Vice-Chairman (*Wichita*)
E. S. Arnold, Vice-Chairman (*E. Kansas*)
J.W. Meyers, Vice-Chairman (*W. Kansas*)
H. L. Temple, Secretary-Treasurer
Continental Oil Co.
Moundridge, Kansas
G. L. Yates, Section Delegate

COMMITTEES

EXECUTIVE
Charles Weinaug — Roy Patrick
B. B. Lane — Lyman Terry

PROGRAM
J. R. Puckett, Chairman
L. L. Terry — R. V. Gerner

MEMBERSHIP
John T. Gary, Chairman
Will D. Ford — John T. Gary
Dennis Krehbiel — Mac. W. Miller

LEHIGH VALLEY

Established March 27, 1924

H. R. Gault, Chairman
R. G. Peets, Vice-Chairman
J. S. Marsh, Vice-Chairman
J. L. Rodda, Vice-Chairman
D. J. Blickwede, Secretary
Bethlehem Steel Corp.
Bethlehem, Pa.
C. A. Lorenson, Treasurer
R. T. Gallagher, Section Delegate
B. J. Larpenteur, Manager
W. A. Griffith, Manager
R. T. Gallagher, Manager

COMMITTEES

HOSPITALITY
A. C. Most, Jr., Chairman
C. R. Neil — J. W. Guider
J. A. Marvin, Jr. — T. G. Foulkes
S. M. Hochberger — W. S. Eberly
D. C. Jillson — P. B. Entrekin
E. C. Domingues

PROGRAM
R. G. Peets, Chairman
R. K. Waring — B. H. Strom
J. F. Libsch — W. S. Cumings

MEMBERSHIP
R. M. Johnson, Chairman
W. A. Griffith — Lawrence Seaman
W. R. Bechdolt — Samuel Epstein
J. P. Bingham — R. W. Jenkins
W. M. Aubrey, Jr. — S. E. Anthony
C. B. Post

NOMINATING
B. J. Larpenteur, Chairman
R. T. Gallagher — J. L. Rodda

STUDENT RELATIONS
E. A. Anderson, Chairman
Allison Butts — C. E. Taylor, Jr.
M. S. Childs — P. L. Steffensen

MID-CONTINENT
Established December 28, 1917

Holds weekly luncheon meetings each Thursday in Tulsa, Oklahoma. Regular Section meetings held second Monday each month except June through August.

Jack Beesley, Chairman
G. C. MacDonald, First Vice-Chairman
M. B. Penn, Second Vice-Chairman
S. F. Bird, Secretary-Treasurer
Amerada Petroleum Corporation
Tulsa, Oklahoma
J. N. McGirl, Section Delegate

EXECUTIVE COMMITTEE
(TULSA)
W. B. Davis
E. H. Nielsen
F. H. Calloway

(OUTSIDE TULSA)
J. A. Murphy
F. H. Poettman

(EX-OFFICIO)
Roy H. Smith
J. N. McGirl

MINNESOTA
Established December 20, 1920

Annual meeting second week in January, other meetings as called by officers

Hugh J. Leach, Chairman
F. D. Devaney, Vice-Chairman
H. F. Kullberg, Vice-Chairman
J. L. Severson, Vice-Chairman
James R. Stuart, Secretary-Treasurer
Box 840, Hibbing, Minn.
Eugene P. Pfleider, Section Delegate

DIRECTORS
W. L. Taylor — Grover J. Holt
C. J. O'Connell

MINING SUBSECTION
David H. Hill, Chairman
A. W. Kangas, Vice-Chairman
Clarence H. Sleeman, Secretary

MINERALS BENEFICIATION SUBSECTION
F. D. DeVaney, Chairman
S. E. Erickson, Vice-Chairman
M. F. Williams, Secretary

MONTANA
Established October 17, 1913

Holds meetings fourth Tuesday of each month

Chester H. Steele, Chairman
Fred W. Strandberg, Vice-Chairman
Clifford J. Hicks, Secretary-Treasurer
526 Hennessy Bldg., Butte, Montana
Joseph T. Roy, Executive Committee
James F. Smith, Executive Committee
Fred W. Strandberg, Section Delegate

COMMITTEES

MEMBERSHIP
Robert C. Weisner, Chairman
George A. Boulter — David R. Nelson
Stanley M. Lane — Forbes Robertson
James F. Smith

PROGRAM
James K. Archibald, Chairman
Carl Trauerman, Co-Chairman
Lester Bishop — W. Wallace Harrity
George W. Boulter — Stanley M. Lane
Thomas K. Graham — Robert L. Thompson
Guy T. Wever

STUDENT AWARDS
Clarence A. Champ, Chairman

Mining—T. Charles Wise
Charles S. Matthews

Geology—Charles C. Goddard, Jr.
Wallace A. O'Brien

Metallurgy—C. F. Milkwick
George T. Hanson

CHAIRMEN ADVISORS ON MEETINGS

Mining—Arthur C. Bigley
Geology—Edward P. Shea
Metallurgy—George G. Griswold
General—J. R. Van Pelt

NOMINATING

Kuno Doerr, Jr., Chairman
Armor B. Martin J. Hollis McCrea

NEVADA

Established January 21, 1916

Albert Silver, Chairman
Arthur J. O'Connor, Vice-Chairman
A. C. Rice, Secretary-Treasurer
U. S. Bureau of Mines
Box D, University P. O.
Reno, Nevada
J. C. Kinnear, Jr., Section Delegate

EXECUTIVE COMMITTEE

John M. Heizer John C. Kinnear, Jr.
A. C. Johnson A. E. Millar
Hubert P. Cheesher, Jr., Chairman, Membership

RENO BRANCH

Holds luncheon meeting second Friday each month except July and August

J. B. Zadra, Chairman
Victor E. Kral, Secretary-Treasurer
Nevada Bureau of Mines
Univ. of Nevada, Reno, Nev.

NEW YORK

Established May 19, 1911

Holds monthly meetings except February, June, July, and August

P. Malozemoff, Chairman
Francis Cameron, Past Chairman
Robert Ramsey, Vice-Chairman
Louis C. Raymond, Vice-Chairman
Alvin W. Knoerr, Secretary
330 W. 42nd St., New York 18, N. Y.
James S. Vanick, Treasurer
Philip D. Wilson, Section Delegate

COMMITTEE CHAIRMEN

W. J. Turner
Henry W. Hitzrot
John H. Ffolliott
L. H. Hart
Maxwell Gensamer
Walter S. Olson
G. Howard LeFevre
A. L. J. Queneau

NORTH PACIFIC

Established March 28, 1913

Holds meetings third Thursday each month except June, July, and August.

Drury A. Pifer, Chairman
A. H. Mellish, Vice-Chairman
M. E. Elmore, Secretary-Treasurer
5041 West Prince St.
Seattle 6, Washington
W. A. G. Bennett, Corresponding Secretary
W. C. Leonard, Section Delegate
Drury A. Pifer, Alternate

Councillors

W. C. Bennett E. W. Heinzinger
J. G. Johnson

COMMITTEES

MEMBERSHIP

D. A. Somerville, Chairman
George Waterman J. A. Richter

PROGRAM

Max R. Geer, Chairman
Joseph Daniels C. R. Low
E. A. Rowe, Student Chapter Counselor

NORTH TEXAS

Established May 16, 1945

R. G. Parker, Chairman
Kenneth F. Anderson, Vice-Chairman
Henry Gruy, Vice-Chairman
Buck Joe Miller, Vice-Chairman
M. I. Taylor, Secretary-Treasurer
P. O. Box 1290, Fort Worth, Texas
Jack A. Crichton, Section Delegate
R. G. Parker, Alternate

DIRECTORS

R. T. Bright Marshall L. Stirling
R. P. Dobyns Everett G. Trostel
Paul M. Wiley

COMMITTEE CHAIRMEN

Program

Fort Worth—K. C. Howard
Dallas—N. A. Tinker

Arrangements

Fort Worth—W. K. Daggett
Dallas—H. A. Metzger

Membership

Fort Worth—R. H. Rantala
Dallas—K. F. Anderson

Committee Chairman

Wichita Falls Area—Buck Joe Miller

OHIO VALLEY
Established November 19, 1920

Theron Reed, Chairman
William H. Smith, Vice-Chairman
James Cunningham, Secretary-Treasurer
Owens-Corning Fiberglas Corp.
Newark, Ohio
Charles Bowen, Asst. Secretary-Treasurer
John H. Melvin, Section Delegate

COMMITTEE CHAIRMEN
Robert Jaffee, Program
William Newton, Membership
Frank Stephens, Jr. Representative
Edwin Miller, Student Representative

AREA REPRESENTATIVES
Worley Albaugh, Cincinnati
George R. Long, Dayton
G. W. Noble, Findlay
Max Tuttle, Indianapolis
Harold Gaw, Middletown
Theron Reed, Newark
Benjamin Eggers, Portsmouth
Keith D. Pfoor, St. Clairsville

OKLAHOMA CITY
Established February 18, 1947

J. C. Cordell, Chairman
R. M. Caywood, First Vice-Chairman
H. W. Benischek, Second Vice-Chairman
N. R. Morgan, Secretary-Treasurer
Sohio Petroleum Co.
Skirvin Tower, Oklahoma City, Okla.
J. H. Field, Section Delegate

DIRECTORS
J. W. Maly
J. H. Field
T. B. Lowary

OREGON
Established April 22, 1921

Holds meetings third Friday of each month except during summer months

James F. Bell, Chairman
Henry Mears, Vice-Chairman
David H. Beetem, Past Chairman
Robert Rasmussen, Secretary-Treasurer
P. O. Box 492, Albany, Oregon
Henry Mears, Section Delegate

EXECUTIVE COMMITTEE
A. O. Bartell
T. C. Waters

COMMITTEE CHAIRMEN
Henry S. Mears, Program
Alex Leipper, Auditing
T. C. Mathews, Entertainment
F. W. Libbey, Legislation
Ralph S. Mason, Publicity
A. O. Bartell, Ind. Minerals Conf.
Lloyd Staples, Student Prize Award

MEMBERSHIP
D. H. Beetem, Chairman
I. S. Allison
John Leary
Lloyd Banning
F. W. Libbey
A. O. Bartell
Ralph S. Mason
M. L. Bingham
James M. Orr
F. X. Cappa
Lloyd Staples
Leverett Davis
N. S. Wagner
K. E. Hamblen
K. O. Watkins
P. R. Hines
D. J. White
Gordon White

DELEGATES TO OREGON TECHNICAL COUNCIL
A. O. Bartell
K. E. Hamblen

PENNSYLVANIA-ANTHRACITE
Established February 17, 1914

Holds meetings alternately at Pottsville, Hazleton, Wilkes-Barre, and Scranton. Spring Meeting, April; Summer Meeting, July; Fall Meeting, October.

D. C. Helms, Chairman
John M. Reid, Vice-Chairman
Floyd S. Sanders, Secretary-Treasurer
Goodman Mfg. Co., P. O. Box 151
Wilkes-Barre, Pa.
Henry Dierks, Section Delegate
D. C. Helms, Alternate

EXECUTIVE COMMITTEE
One Year—
Carroll A. Garner
W. Julian Parton
Edward G. Fox
E. L. Dana
W. M. Romischer

Two Years—
William W. Everett
George J. Clark
Edward T. Powell
James H. Pierce
William C. Muehlof

Three Years—
Adrian E. Rose
K. F. Arbogast
Joseph Crane
John T. Griffiths
Arthur E. Dick, Jr.

J. T. Griffiths, Membership Chairman

PERMIAN BASIN

Established November 14, 1945

Raymond E. Howard, Chairman
James C. Blackwood, Vice-Chairman
J. T. Lewis, Secretary-Treasurer
Kobe, Inc., Midland, Texas
Jack M. Moore, Section Delegate

BOARD OF DIRECTORS

James C. Blackwood — J. T. Lewis
Joe Chastain — Jack M. Moore
Raymond E. Howard — R. S. Ousterhout

COMMITTEES

PROGRAM

James C. Blackwood, Chairman
John R. Brack — Marion K. Main
David Johnston — F. D. Priebe

MEMBERSHIP

Rufus P. Kirk, Chairman
Robert E. Kellerman — I. W. Lovelady

ARRANGEMENTS

J. T. Lewis, Chairman
Bryan L. Denson — C. E. Shilcutt

STATISTICAL REPORT

John C. McCarthy, Chairman

SOUTH PLAINS SUBSECTION

Norman Lamont, Chairman
D. D. Bowersock, Vice-Chairman
Windford M. Jones, Vice-Chairman
Marvin Willis, Secretary-Treasurer

PHILADELPHIA

Re-established March 15, 1944

Dinner and meeting held last Thursday of each month except June through September

D. I. Finch, Chairman
A. A. Bradd, Senior Vice-Chairman
Felix B. Litton, Second Vice-Chairman
F. J. Dunkerley, Secretary-Treasurer
Towne Scientific School,
Univ. of Pennsylvania, Philadelphia 4, Pa.
A. A. Bradd, Section Delegate

EXECUTIVE COMMITTEE

Above officers and
Edward Korostoff — C. Balke
Arthur Bounds
A. L. Jamieson, Past Chairman

COMMITTEES

Felix B. Litton, Chairman, Program
F. B. Foley, Chairman, Student Papers
Arthur Bounds — C. Balke
A. A. Bounds, Chairman, Publicity
William Barth — F. L. Vogel, Jr.
F. B. Foley, Chairman, Nominating
A. L. Jamieson
E. Korostoff, Chairman, Membership

PITTSBURGH

Established April 1920

G. J. Donaldson, Chairman
R. F. Miller, Vice-Chairman
E. H. Hollingsworth, Secretary
Aluminum Research Laboratories
New Kensington, Pa.
R. D. Snouffer, Treasurer
Linwood Thiessen, Section Delegate

EXECUTIVE COMMITTEE

N. G. Alford — D. T. Rogers
H. G. Botset — D. W. Pettigrew, Jr.
A. J. Breitenstein — J. T. Ryan, Jr.
G. Derge — W. G. Stevenson
S. Feigenbaum — C. H. Sawyer
W. B. Gealy — J. M. Stewart
H. P. Greenwald — Linwood Thiessen
M. G. Gulley — W. L. Wearly
J. B. Morrow — A. B. Wilder

Ex officiis

H. N. Eavenson — L. E. Young
Linwood Thiessen, Chairman,
Annual All-Day Off-the-Record Technical Session

ST. LOUIS

Established May 23, 1913

Curtis L. Wilson, Chairman
Fred J. Meek, Vice-Chairman
John D. Kerr, Jr., Secretary-Treasurer
511 Locust St., St. Louis 1, Mo.
Clyde S. Smith, Section Delegate

EXECUTIVE COMMITTEE

Carl H. Cotterill — James B. Macelwane
John S. Brown — Paul R. Hamilton
Morris M. Fine — J. Marshall Thompson

COMMITTEE CHAIRMEN

Jules C. George, Membership
Fred J. Meek, Student Papers Contest
Charles W. Ambler, Jr., Program

SAN FRANCISCO

Established June 26, 1913

Holds meetings second Wednesday of each month except June through August; and Monday noons for luncheon at Engineers' Club

Walter L. Penick, Chairman
J. G. Huseby, Vice-Chairman
Malcolm B. Gould, Secretary-Treasurer
1100 Mills Bldg.
San Francisco 4, Calif.
Walter L. Penick, Section Delegate

COMMITTEES

EXECUTIVE
Walter L. Penick
J. G. Huseby
M. B. Gould
J. C. Lokken — G. H. Playter
L. A. Parsons — G. F. Trescher

PROGRAM
J. G. Huseby, Chairman
H. C. Miller — Alfred B. Sabin
O. Cutler Shepard — Olaf P. Jenkins

MEMBERSHIP
J. C. Lokken, Chairman
R. L. Baldwin — R. A. Kinzie, Jr.
E. M. Barker — P. J. McGuire
B. A. Gould — W. C. Mason
E. A. Hassan, Jr. — Spangler Ricker
J. B. Huttl — B. K. Shedd
G. P. Hurst — W. A. Vogt
H. P. Wagner

STUDENT CONTACT
Charles F. Park, Jr., Chairman
Fred L. Humphrey — Edward Wisser
Bernard York
President, U. C. Mining Association
President, Stanford Mining Association

STUDENT PRIZE
W. W. Mein, Jr., '53, Chairman
R. E. Byler, '54
D. H. McLaughlin, '55
O. Cutler Shepard, '53

NOMINATING
Worthen Bradley, Chairman
W. S. Reid — H. A. Sawin
Lawrence B. Wright

TAX
Granville S. Borden, Chairman
I. S. Joralemon — S. H. Williston

LICENSING
Lawrence B. Wright, Chairman
G. S. Borden — Rodgers Peale
C. N. Schuette

ENTERTAINMENT AND HOSPITALITY
Granville S. Borden, Chairman
T. C. Baker — Jack H. How
M. B. Gould — H. A. Sawin

ADVISORY
Lawrence B. Wright, '52, Chairman
W. W. Mein, Jr., '53
P. R. Bradley, Jr., '55
Edward Wisser, '54
G. H. Playter, '56

FINANCE
A. A. Hoffman, Chairman
W. C. Collyer — L. T. T. Kett
G. W. Vreeland

ADVISORY TO ENGINEERING SOCIETIES EMPLOYMENT SERVICE
W. Spencer Reid, Chairman
E. P. Bullard — C. F. Williams

LEGISLATIVE
Philip R. Bradley, Jr.
B. C. Austin — G. S. Borden

ENGINEERING COUNCIL
George H. Playter, Chairman
J. G. Huseby — W. L. Penick

ROSTER
H. A. Sawin, Chairman
J. P. Bradley — J. G. Huseby
G. I. Gould — J. C. Lokken
W. S. Reid

SOUTHEAST

Established February 18, 1936

Lamar Weaver, Chairman
E. H. Rose, First Vice-Chairman
Alfred Shook III, Second Vice-Chairman
V. L. Hill, Secretary-Treasurer
Tennessee Copper Co.
Ducktown, Tenn.
E. H. Rose, Section Delegate

DIRECTORS
P. G. Cowin — W. C. McKenzie
H. F. Kendall — C. R. L. Oder
Nelson Severinghaus
A. J. Blair, Representative to The Birmingham Engineers Council

COMMITTEES

MEMBERSHIP
Frank Doyle, Chairman
T. L. Kessler M. J. Langley
E. C. Miller

PROGRAM
H. F. Kendall, Chairman
W. M. Black John W. Hager
Nelson Severinghaus

ENTERTAINMENT
F. M. Lewis, Chairman
R. C. Crumbaugh I. W. Johnson

PUBLICITY
J. B. Moncrief, Chairman
A. W. Beck R. G. Clay
Garland Peyton

SCHOOL
J. R. Thoenen, Chairman
A. T. Allen F. C. Kruger
R. J. Raudebaugh E. H. Stevens

RESOURCES INDEX
W. W. Simmons, Chairman
Owen Kingman R. A. Laurence

SOUTHERN CALIFORNIA
Established May 23, 1913

Basil Kantzer, Chairman
J. L. Taylor, Vice-Chairman
R. M. Stewart, Jr., Vice-Chairman
Basil Kantzer, Section Delegate

DIRECTORS
Wayne E. Glenn, Petroleum Branch
Fred S. Boericke, Metals Branch
N. A. D'Arcy, Jr., Mining Branch

COMMITTEE CHAIRMEN
C. M. Bernt, Membership
Joseph Jensen, Fall Meeting
W. T. Wallace, Employment
Paul Andrews, Student Affairs
Jordan Nathason, Publicity
C. W. Six, Finance

SOUTHWEST TEXAS
Established September 18, 1946

Holds meetings second Wednesday of each month except July, August and December

Harry D. Vaughan, Chairman
Barrett Booth, Vice-Chairman
Joseph B. Woodward, Secretary-Treasurer
Seaboard Oil Co. of Del.
P. O. Box 601, Corpus Christi, Texas
Harry D. Vaughan, Section Delegate

DIRECTORS
Charles Barnes J. T. May
R. E. Bates R. B. Sale
R. J. Granberry Don F. Shaw
T. E. Keefer W. J. Turner

COMMITTEE CHAIRMEN
Chester L. Wheless, Membership
Don F. Shaw, Program
Francis J. Herbert, Reception and Entertainment
Raymond Keller, Jr., Publicity and Correspondent to Journal
John W. Crutchfield, Counselor to Student Chapter at A. & I. College

SOUTHWESTERN ALASKA
Established February 1951

Holds meetings fourth Monday of each month.

Phil R. Holdsworth, Chairman
John McAnerny, Vice-Chairman
Wiley Robinson, Vice-Chairman
Ludlow G. Anderson, Secretary-Treasurer
Region 1, U. S. Bur. of Mines,
Box 2259, Anchorage, Alaska

EXECUTIVE COMMITTEE
Eugene P. Erickson Walter Erickson
Glen Chambers

SOUTHWESTERN NEW MEXICO
Established September 30, 1947

Holds meetings second Wednesday in January, April, July, and October.

Elton Clark, Chairman
John H. Soule, First Vice-Chairman
George F. Coope, Jr.,
Second Vice-Chairman
David W. Boise, Secretary-Treasurer
917 West St., Silver City, New Mexico
J. W. Faust, Section Delegate

COMMITTEES

MEMBERSHIP
W. C. Wood, Chairman
R. A. Elgin P. R. Smith, Jr.
Bert C. Morrison J. F. Stock, Jr.

PROGRAM
B. S. Hardie, Chairman
P. V. Brough R. W. Mathis
J. S. Babcock R. W. Shilling

TRI-STATE
Established May 27, 1926

W. F. Netzeband, Chairman
R. O. Cash, Vice-Chairman
Dan R. Stewart, Secretary-Treasurer
P. O. Box 870, Joplin, Mo.
J. C. Stipe, Section Delegate
E. H. Crabtree, Jr., Alternate

DIRECTORS
W. F. Netzeband Sim Clarke
D. R. Stewart J. C. Stipe
Robert Illidge Curtis Stover
Robert Cash Ernest Blessing

COMMITTEE CHAIRMEN
Sim Clarke, Program
Ernest Blessing, Membership

UPPER PENINSULA
Established October 25, 1918

Robert K. Poull, Chairman
Clyde Nicolson, Vice-Chairman
Roy W. Drier, Secretary-Treasurer
715 Pine St., Calumet, Mich.
Roy W. Drier, Section Delegate
B. H. Boyum, Alternate

EXECUTIVE COMMITTEE
A. J. Christenson S. E. Quale
R. K. Poull F. J. Haller
R. W. Drier J. O. Greenslade
B. H. Boyum

COMMITTEES

NOMINATING
Carl Brewer, Chairman
T. M. Broderick John M. Bush

FINANCE
Roy W. Drier
A. J. Christenson

PROGRAM
Roy W. Drier, Chairman
Kelly Campbell J. Murray Riddell
R. C. Mahon F. L. Partlo
R. K. Poull D. S. Young
A. J. Christenson

MEMBERSHIP
Fred W. Denton, Chairman
L. A. Roe J. S. Westwater
Stephen Royce

STUDENT RELATIONS
A. K. Snelgrove, Chairman
C. M. Harry Roy W. Drier

ENTERTAINMENT
Waldemar A. Knoll, Chairman
F. J. Smith R. D. Satterley
H. S. Peterson E. L. Derby
R. K. Poull

PUBLICITY
Roy W. Drier Peter P. Ribotto

PROFESSIONAL STANDARDS
Fayette E. Brown, Chairman
C. D. Bailey E. L. Derby

UTAH
Established April 24, 1914

Meets third Thursday of each month, September to May, inclusive

W. G. Rouillard, Chairman
Clark W. Wilson, Vice-Chairman
Harry P. Allen, Secretary-Treasurer
1316 Penn St., Salt Lake City 5, Utah
Whitman G. Rouillard, Section Delegate

EXECUTIVE COMMITTEE
Carlos Bardwell H. L. Johnson
C. J. Christensen J. C. Landenberger, Jr.

COMMITTEE CHAIRMEN
B. L. Sackett, Membership
Burt B. Brewster, Publicity
D. F. McElhattan, Entertainment
Robert S. Lewis, Student Affairs

WASHINGTON D. C.
Established June 21, 1918
Holds meetings usually third Tuesday of each month except June through August.
A. C. Fieldner, Chairman
Max W. Ball, Vice-Chairman, D. C.
C. J. Williamson, Vice-Chairman, Md.
Olaf Rove, Vice-Chairman, Va.
Jack W. Clark, Secretary-Treasurer
P. O. Box 663, Washington 4, D. C.
Paul M. Tyler, Section Delegate

EXECUTIVE COMMITTEE
F. S. Lott E. R. Maize
C. E. Stott

MEMBERSHIP COMMITTEE
Sheldon P. Wimpfen, Chairman

WYOMING

Established May 16, 1930

Holds regular meetings quarterly; special meetings when speakers are available. (Officers' terms expire Nov. 1953)

Henry G. Fisk, Chairman
G. B. Gaylore, Vice-Chairman
Charles E. Johnson, Secretary-Treasurer
Green River, Wyoming
Henry G. Fisk, Section Delegate
Charles E. Johnston, Alternate

COMMITTEES

EXECUTIVE
H. C. Livingston, Chairman
M. M. Fidlar G. E. Sorenson

MEMBERSHIP
I. M. Charles, Chairman
T. L. Johnston Lyman Fearn
E. R. Lund

PROGRAM
Charles Johnston, Chairman
Neil Rice R. M. Churchwell

FOREIGN SECTIONS

MEXICO

Established 1950

Holds monthly luncheon meetings first Monday of each month at American Club, Mexico City

Alfredo Terrazas, Chairman
Jose Garcia, Vice-Chairman
William G. Kane, Secretary-Treasurer
Apartado 711, Mexico, D. F., Mexico

EXECUTIVE COMMITTEE
Gustavo Serrano H. F. Hurley
Alex Edelen Ignacio Bonillas
Manuel Villafana
Alex Edelen, Chairman, Membership Committee

PHILIPPINE

Established January 20, 1939

Nestoria N. Lim, Chairman
J. B. Stapler, Vice-Chairman
Amadeo Rodriguez, Secretary
Indust. Safety Div., Dept. of Labor
Manila, P. I.

EXECUTIVE COMMITTEE
Clarence A. Weekly
Walter R. Thormeyer

RIO DE JANEIRO (BRAZIL)

Established April 17, 1936

Meets second Thursday of each month at Av. Rio Branco 128, Room 410

E. de Macedo Soares S., Chairman
A. I. de Oliveria, Vice-Chairman
Harvey Hakala, Vice-Chairman
Sílvio Froes Abreu, Secretary
Instituto Nacional de Tecnologia
Rio de Janeiro, Brazil, S. A.
H. C. Alves de Sousa, Treasurer

LIMA (PERU)

Established May, 1952

STUDENT CHAPTERS AND FACULTY SPONSORS

UNIVERSITY OF ALABAMA

University, Ala.
Mining & Metallurgical Society
James W. Stewart

UNIVERSITY OF ALASKA

College, Alaska
Mining Society of the University of Alaska
Guinn Metzger

UNIVERSITY OF ARIZONA

Tucson, Arizona
Miners' Society
H. Krumlauf

BIRMINGHAM-SOUTHERN COLLEGE

Birmingham, Ala.
Pick & Hammer Club
Daniel D. Arden

UNIVERSITY OF BRITISH COLUMBIA
Vancouver, British Columbia
G. M. Dawson Club
A. Gunning

UNIVERSITY OF CALIFORNIA
Berkeley, Calif.
Mineral Technology Association
Bernard York

CARNEGIE INSTITUTE OF TECHNOLOGY
Pittsburgh, Pa.
The Metals Club
Gerhard Derge

CASE INSTITUTE OF TECHNOLOGY
Cleveland, Ohio
Pick and Shovel Club
Gerald M. Cover

CITY COLLEGE OF NEW YORK
New York, N. Y.
CCNY Student Chapter AIME
Daniel T. O'Connell

COLORADO SCHOOL OF MINES
Golden, Colo.
Student Chapter AIME
Sigmund L. Smith

COLUMBIA UNIVERSITY SCHOOL OF MINES
New York 27, N. Y.
Thomas Thornton Read Society
Herbert H. Kellogg

CORNELL UNIVERSITY
Ithaca, N. Y.
Cornell Metallurgical Society
J. L. Gregg

UNIVERSITY OF HOUSTON
Houston, Texas
C. V. Kirkpatrick

UNIVERSITY OF IDAHO
Moscow, Idaho
Associated Miners
Joseph Newton

UNIVERSITY OF ILLINOIS
Urbana, Ill.
Mineral Industry Society
W. R. Chedsey

ILLINOIS INSTITUTE OF TECHNOLOGY
Chicago, Ill.
Student Chapter AIME
Otto Zmeskal

IOWA STATE COLLEGE
Ames, Iowa
Iowa State Mining Society
Charles O. Frush

UNIVERSITY OF KANSAS
Lawrence, Kan.
Student Chapter AIME
Hubert E. Risser

UNIVERSITY OF KENTUCKY
Lexington, Ky.
Norwood Mining & Metallurgical Society
Charles Stevens Crouse

LAFAYETTE COLLEGE
Easton, Pa.
John Markle Society
William B. Plank

LEHIGH UNIVERSITY
Bethlehem, Pa.
Howard Eckfeldt Society of Mining & Geology
R. T. Gallagher

LOUISIANA STATE UNIVERSITY
University, La.
Student Chapter AIME
B. C. Craft

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge 39, Mass.
MIT Metallurgical Society
N. J. Grant

UNIVERSITY OF MICHIGAN
Ann Arbor, Mich.
Univ. of Michigan Student Society AIME
Clarence A. Siebert

MICHIGAN COLLEGE OF MINING AND TECHNOLOGY
Houghton, Mich.
Student Chapter AIME
Charles M. Harry

UNIVERSITY OF MINNESOTA
Minneapolis, Minn.
School of Mines Society, AIME
Eugene P. Pfleider

MISSOURI SCHOOL OF MINES AND METALLURGY
Rolla, Mo.
Student Chapter AIME
D. R. Schooler — D. F. Walsh

MONTANA SCHOOL OF MINES
Butte, Mont.
Anderson-Carlisle Technical Society
George J. Grunenfelder

UNIVERSITY OF NEVADA MACKAY SCHOOL OF MINES
Reno, Nev.
Crucible Club
V. P. Gianella

UNIVERSITY OF NEW HAMPSHIRE
Durham, N. H.
Student Chapter AIME
Glenn W. Stewart

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY
Socorro, N. Mex.
Cooney Mining Club
Gerald U. Greene

NEW YORK UNIVERSITY
University Heights, New York 53, N. Y.
NYU Student Chapter AIME
John P. Nielson

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING
Raleigh, N. C.
Rockhound Club
Glenn Ernest McKinley

UNIVERSITY OF NORTH DAKOTA
Grand Forks, N. D.
The Mining Club
J. J. Daly

OHIO STATE UNIVERSITY
Columbus, Ohio
AIME Student Branch
William A. Mueller

UNIVERSITY OF OKLAHOMA
Norman, Okla.
Petroleum Engineers' Club
W. F. Cloud

OKLAHOMA INSTITUTE OF TECHNOLOGY
Oklahoma A & M College
Stillwater, Okla.
Petroleum Club
John P. Everett

OREGON STATE COLLEGE
Corvallis, Ore.
OSC Student Chapter AIME
William E. Caldwell

UNIVERSITY OF PENNSYLVANIA
Philadelphia, Pa.
Metallurgical Engineering Society
R. M. Brick

PENNSYLVANIA STATE COLLEGE
State College, Pa.
Mining Engineering Society
Arnold W. Asman
Petroleum Engineering Society
O. F. Spencer

UNIVERSITY OF PITTSBURGH
Pittsburgh 13, Pa.
Student Chapter AIME
E. A. Wines

POLYTECHNIC INSTITUTE OF BROOKLYN
Brooklyn 2, N. Y.
Student Chapter AIME
Otto H. Henry

PRINCETON UNIVERSITY
Princeton, N. J.
Student Chapter AIME
W. T. Thom, Jr.

COLLEGE OF PUGET SOUND
Tacoma, Wash.
Geological Society
F. A. McMillin

PURDUE UNIVERSITY
Lafayette, Ind.
Student Society AIME
George M. Enos

RUTGERS UNIVERSITY
New Brunswick, N. J.
Rutgers Geology Club
Helgi Johnson

ST. LOUIS UNIVERSITY INSTITUTE OF TECHNOLOGY
St. Louis 8, Mo.
St. Louis Univ. Student Chapter AIME
Albert J. Frank

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY
Rapid City, S. D.
Drill and Crucible Club
John Paul Gries

UNIVERSITY OF SOUTHERN CALIFORNIA
Los Angeles, Calif.
USC Student Chapter AIME
Carrol M. Beeson

STANFORD UNIVERSITY
Stanford, Calif.
Geological & Mining Society
O. Cutler Shepard — Charles Park

A. & M. COLLEGE OF TEXAS
College Station, Texas
Petroleum Engineering Club
Joe A. Laird

TEXAS COLLEGE OF ARTS AND INDUSTRIES
Kingsville, Texas
Engineers Association
Frank H. Dotterweich

TEXAS WESTERN COLLEGE
El Paso, Texas
Kidd Mining Club
John F. Graham

TEXAS TECHNOLOGICAL COLLEGE
Lubbock, Texas
Student Chapter, AIME
W. L. Ducker

UNIVERSITY OF TEXAS
Austin, Texas
AIME Student Chapter
J. M. Lebeaux

UNIVERSITY OF TORONTO
Toronto, Ont., Canada
Mining & Metallurgical Club
Richard E. Barret

UNIVERSITY OF TULSA
Tulsa, Okla.
A. W. Walker

UNIVERSITY OF UTAH
Salt Lake City, Utah
Mining Society of Univ. of Utah
Robert S. Lewis

VIRGINIA POLYTECHNIC INSTITUTE
Blacksburg, Va.
Burkhart Mining Society
Charles T. Holland

WASHINGTON UNIVERSITY
St. Louis, Mo.
Walter E. McCourt Memorial Chapter AIME
Norman S. Hinchey

WASHINGTON STATE COLLEGE
Pullman, Wash.
Associated Muckers
Joseph W. Mills

UNIVERSITY OF WASHINGTON
Seattle 5, Wash.
Mines Society AIME
H. Gordon Poole

WAYNE UNIVERSITY
Detroit, Mich.
Charles A. Nagler

WEST VIRGINIA UNIVERSITY SCHOOL OF MINES
Morgantown, W. Va.
Student Chapter AIME
R. W. Laird

UNIVERSITY OF WICHITA

Wichita, Kan.
Geology Club

UNIVERSITY OF WISCONSIN

Madison 6, Wis.
Mining and Metallurgy Club
George J. Barker

WISCONSIN INSTITUTE OF TECHNOLOGY

Platteville, Wis.
Carl R. Christiansen

YALE UNIVERSITY

New Haven 11, Conn.
Yale Metallurgical Society
W. R. Hibbard, Jr.

OFFICERS OF THE WOMAN'S AUXILIARY

PRESIDENT

Mrs. Oliver Bowles
5000 Massachusetts Ave. N.W.
Washington 16, D. C.

FIRST VICE-PRESIDENT

Mrs. David Eugene Park
350 East 57th Street
New York 22, N. Y.

SECOND VICE-PRESIDENT

Mrs. A. B. Kinzel
320 Park Avenue
New York 22, N. Y.

THIRD VICE-PRESIDENT

Mrs. Harold J. Clark
129 North Lucerne Blvd.
Los Angeles 24, Calif.

FOURTH VICE-PRESIDENT

Mrs. Thomas P. Clendenin
2735 Silver Street
El Paso, Texas

FIFTH VICE-PRESIDENT

Mrs. R. E. Kirk
3017 Highland Avenue
Birmingham 5, Ala.

RECORDING SECRETARY

Mrs. W. McG. Peirce
7 Lexington Avenue
New York 10, N. Y.

ASST. RECORDING SECRETARY

Mrs. Arnold H. Miller
601 West 115th Street
New York 25, N. Y.

CORRESPONDING SECRETARY

Mrs. Theodore Nagel
76 Remsen Street
Brooklyn 2, N. Y.

TREASURER

Mrs. Robert W. Rowen
115 East 67th Street
New York 21, N. Y.

ASSISTANT TREASURER

Mrs. Reed W. Hyde
84 Mountain Avenue
Summit, New Jersey